ENGINEERING NEWS

TWICE in the past week travel on the Brooklyn bridge has been interrupted by accidents due to switching, once by a derailment and once by a collision, each time blocking traffic for about an hour. The first was due to derailment on a frog. The second was as follows: The switch engine failed to couple automatically, as it does occasionally, and had to back off to get a fresh start. It was in the rush hour, and the next train was close at hand. A danger signal was displayed, but it was not obeyed till too late and a rear collision occurred. The only injury was to knock over an old lady of 70 who received "an abrasion under the right eye and a severe nervous shock". She was carried off in an ambulance and the conductor was discharged, so justice was satisfied. The greatest danger in the present comparatively safe method of operating is that a panic or row on the overcrowded platforms will throw a lot of people in front of an approaching train. So far nothing of the kind has happened; perhaps it never may.

A terrible amount of Aqueduct dirty linen has been washed this week, and hung out in the public press to dry. Precisely how and why it became so dirty, and what the precise causes are which have brought its condition all out to the public view at this late day we do not feel called upon to summarize, but it appears to be clear that Messrs. CLARK & O'BRIEN made things pleasant for an assortment of city politicians for value received, to the extent of surrendering about half their prospective profits to a triumvirate consisting of JOHN KEENAN, the boodler now in exile, MAURICE B. FLYNN, of savory memory, and JOHN H. MOONEY, brother-in-law of the Tammany leader KEARNEY. There was even included the payment of certain notes of Gov. HILL, if the nominal testimony be not slander. Altogether it is a bad looking business with only two redeeming features which do not seem to strike the daily press; (1) the aqueduct is a cheap one after all is said and done, and the city has not been stuck much, and (2) the sub-letting of certain work at "10 to 20 per cent. profit" without the main contractors "doing a stroke of work on it", is anything but an unusual or *prima facie* fraudulent performance. All contractors for large work expect to sub-let at about that profit. To be sure sub-letting was forbidden by the contract, but such provisos are always liable to evasion.

Two other deaths from electric shocks due to touching arc lamps will, we trust, lead to a reformation in regard to that terrible and wholly unnecessary danger. There should certainly be no projecting part of the lamp which the hand can touch which is not thoroughly insulated from the current, as there is not the slightest difficulty in doing it and only a very trifling expense.

THE spring floods have been doing much damage in the Southwest, and many miles of washouts have occurred in Texas and Indian Territory. The waters still continue high in the rivers of the Northwest. The Hudson river has overflowed at Albany, N. Y. In New England also the waters are high, and considerable damage has been done; the track of the Meriden & Cornwall line has been under water in places.——A landslide occurred on the Northern Pacific Railroad near Bismarck, Dak., April 27. Another slide occurred April 27 near Cumberland, Md., at the east end of the canal tunnel.——A portion of the dam of the Polar Star mills at Faribault, Minn., has been undermined by the water: repairs are being made. The water-works dam at Laramie, Wyo., gave way April 14, but has been repaired.——A cyclone struck the eastern part of the city of Pratt, Kan., April 27.

THE following bridge accidents are reported: On April 27 a 60-ft. bridge near Alma, Neb., on the Burlington & Missouri River Railroad, was weakended by the floods undermining the foundations, and gave way under a fast passenger train. The engine, baggage and mail cars went down; the other cars were derailed and telescoped; the wreck caught fire and was burnt. Two persons were killed and about 6 injured.——The Cassell creek bridge (or trestle) on the Indianapolis & St. Louis Railway, near Mattoon, Ill., was burnt April 27.——The Valley creek bridge on the East Tennessee, Virginia & Georgia Railroad, near Selma, Ala., was burnt April 27. It was a covered bridge, built of wood, about 75 ft. long.——Several bridges have been washed away near Atoka, Indian Ty. Three railroad bridges between Denton and Whitesboro, Tex., have been washed away by the floods; also a bridge between Denton and Dallas on the Dallas & Wichita line. The Maine creek bridge near Fort Worth, Tex., was washed away April 28.

ABOUT the worst accident of the week was a "spreading of rails" derailment on the Western N. Y. & Penna. R. R., April 28,4 having been fatally injured and 16 others seriously hurt, out of 40 passengers in the three cars which rolled down the bank. It is a pity that "spreading of rails" cannot be struck out from the reported causes of derailment, for although cases no doubt occur where the term correctly describes the cause of derailment, yet in more the wheels simply jump the rails from some unknown combination of defects in rails, wheels, joints, and track surface, and the "spreading" is a mere effect and not a cause; and it is practically impossible to tell in any case whether it is really effect or cause, unless the track is in unusually bad condition.

THE Mullen tunnel on the Northern Pacific Railway has been burned out, but not so badly as first reported. On the west end the road runs out of the tunnel through a long cut, which was protected by snow sheds. It was these sheds which were first burned. The wind at the time was from the west and blew the smoke and fire into the tunnel, burning some of the timber work. The report that the timber work through the entire length of the tunnel had been destroyed is declared erroneous, for the reason that there is only 130 ft. of it at the western end, after which the tunnel runs through the solid rock for a long distance. Just how much timber is burned is not yet certain, as the dirt slid down by reason of the heat and completely stopped the mouth of the tunnel, making excavation necessary. One of the reasons for the intense heat lay in the manner of construction. The aperture of the tunnel was much higher than necessary, and the roof of the sheds was made some distance below it in order to save timber. This vacant space over the roof was filled with cordwood, as a protection against falling rocks, which furnished good fuel for the flames.

The temporary loss of this tunnel is balanced by the opening of the Cascade or Stampede tunnel which will be ready for use in a very few days. This tunnel is 9,850 ft. long, through solid rock nearly all the way, and has been finished as the work proceeded so that nothing will remain to be done after the final piercing but to lay the track. Work was begun early in 1886, the contract being for about $2,000,000. The pressure of the mountain is so great that inverted stone arches were requir d in some places to prevent clay being forced up from the bottom. A small stream falling directly over the mouth of the tunnel furnished power for the electric light used. Ingersoll and Clayton compressors were used and Ingersoll Eclipse drills. NELSON BENNETT was contractor.

THE bill abolishing the present Board of Trustees of the New York & Brooklyn Bridge, and substituting only 3 trustees for 30, passed the Assembly by a vote of 91 to 15 on May 1, and now goes back to the Senate, which it has once passed unanimously, in its amended form. The running of four-car trains on the bridge, which was promised for the beginning of last month, is now expected to begin some time in the present month.

AFTER visiting the MEIGS elevated road at Cambridge, examining cars and engine, taking a trial trip, and listening to Capt. MEIGS' explanation of his designs and models, the committee on street railroads of the Massachusets Legislature on May 1, voted unanimously in favor of giving the Mayall, Reilly, and Hinckley elevated systems leave to withdraw, and to extend the charter of the Meigs Elevated Railway Company two years, and to remove the restriction that there must first be built a mile of this road in Cambridge.

IT is said that a Russian has discovered a filament to be used in incandescent lamps, capable of standing so high a temperature that from 2 to 4 times as much light can be secured from a given expenditure of power as has been claimed by the Westinghouse and Edison companies. The lamps supplied with these filaments will give more light for the horse-power than 2 arc lamps. If this be true the effect on electric lighting will be very marked, as it will at once double the capacity of existing plants and save a large percentage of fuel. The Westinghouse Co. is said to have secured the right to use the device.

No. 1 SHAFT of the Calumet and Hecla mine, which has been on fire for 6 months, was reopened April 24 and the indications are that the fire is entirely extinguished, although the damage to the mine cannot be estimated.

A MEXICAN correspondent of the London *Financial News* gives a very rose colored view of the condition and prospects of the Mexican Central. He reports that a change in the whole aspect of the country is occurring along the line, and new sources of traffic are developing at a rapid rate.

THE date for doing away with car stoves in New York has been put off from May 1 until Nov. 1, by a bill just signed. Of course such a postponement, if it goes no further, makes no substantial difference, since no heating is necessary *ad interim*. Whether it is merely an entering wedge to further postponement can only be surmised.

THE Kansas City Railway & Tunnel Co's new tunnel at 8th St. was finally completed by R. P. MCCORMICK & Co., contractors, on April 7. Much delay was caused by a succession of heavy falls, and a very hard winter. After completing the excavation and timbering from end to end with 12 in. timbers, the space between timbers being only 6 to 12 ins., a cave occurred near the middle of the tunnel extending 80 ft. and breaking away 30 to 40 ft. above the timber line. This cave caused a month's delay, and cost $20,000. There were about eight heavy caves in all. The timbering was 12 ins. square, and much of it first-class oak. In some places the timbers were placed 6 ins. apart and doubled, one on top of the other. The formation consisted of limestone, clay, slate, shale and heavy clay seams of about the consistency of cream. The work cost twice as much as was estimated by the Chief Engineer, and from its commencement May 10, 1887, until finished, was carried on day and night 7 days per week, without the loss of a single hour. In the first six weeks a force of about 200 men only moved 10 ft.

THE progress made on the Forth bridge is shown by the quarterly report of the Board of Trade, which says that up to the present 585,000 cu. ft. of granite have been delivered, and 560,320 cu. ft. have been set; and about 111,950 cu. yds. of rubble masonry and concrete work have been built. In all 48,300 tons of steel, an addition of 1,560 tons since last report, have been delivered. The average number of men employed per diem during the quarter has been 3,090, and the number employed on Feb. 27 was 2,940.

IN an interview in regard to the Brooklyn bridge terminal question, which appears in the *Sun* of May 4, Mr. THOS. C. CLARKE declares that he not only has been, but is now, in favor of the circulating system as designed by Mr. WELLINGTON and recommended by the Board of Experts, in the following words:

"Mr. CLARKE said that he was in favor of the circulating system of Mr. WELLINGTON before the Board met, and would have voted for it but for the enormous sum which Superintendent MARTIN said it would cost. "I still believe", said he, "that it is the proper system, and I would not vote for Mr. MARTIN'S plan until it was agreed to do away with switches at the head of the incoming tracks by" gauntleting the rails across the bridge.

The kaleidoscopic changes of the Brooklyn bridge problem come almost too quick for us to record them, and still less to comprehend them.

The Process of Electric Welding.

Among the wonderful discoveries and inventions of the last ten or twelve years, the most noticeable have been in the direction of the control and use of electricity; of all these new processes, perhaps that of electric welding is the most recent. The telephone was introduced in 1876, and has developed into the long distance lines recently established, by which ordinary conversation may now be carried on through a distance of 400 miles as readily as though the persons speaking were in adjoining rooms, and a whispered conversation has lately been transmitted between Boston and Worcester, Mass. The electric arc light made its appearance a few years later, and has already taken a permanent place, with a reasonable degree of perfection in its practical working, while the incandescent lighting system is now displacing gas in private houses. Parallel with these developments the electric motor has been applied to numerous uses requiring moderate amounts of power, is now in process of introduction as a motive power on street railways, and its capacity is being increased to make available larger and larger quantities of power. But the application and special adaptability of this same agent to the welding of all kinds of metals was absolutely unknown to the world, until Prof. ELIHU THOMSON obtained patents, dated Aug. 10, 1886, which may be regarded as the foundation of a new art. The methods by which the results obtained up to the present time are reached in this process, are perfectly simple, and are two in number. They are the direct and the indirect method, each of which has its advantages according to circumstances.

By the direct method a continuous current of electricity of low potential and great quantity may be supplied either from a dynamo or a collection of battery cells arranged in series of sufficient power to heat the metals which are brought together at the terminals of the circuit sufficiently to produce welding.

By the indirect method the current from an alternating current dynamo is found to be best adapted for the purpose and is used by induction for producing the welding current by means of a heavy secondary coil. The combination forms a reversed induction coil, which is the same thing in principle as the transformer used for converting a high potential arc light current into a low potential current

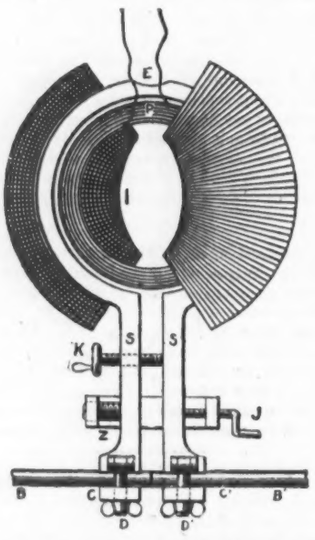


Diagram of Electric Welding Machine.

for incandescent lighting. The principle of the welding machine may be explained by the figure. The alternating current from the dynamo, which is driven by steam engine power, passes through a coil, *P*, of fine insulated wire and thence in a closed circuit back to the dynamo. Around this coil is a single turn of a large copper bar the extremities of which are extended into holders for the pieces to be welded. The shape of this coil is compared by Prof. THOMSON to that of a jewsharp, and is that in which the welding current is induced. The core of the induction coil is in this case outside and consists of a large coil, *II*, of soft iron wire, which is wrapped around both the primary and secondary coils. The induction coil is indeed simply a dynamo at rest.

The iron wire coils forming the core of the induction coil are replaced, in the machines placed upon the market, by a set of transformed plates of very thin and soft sheet iron, which are packed together to the number of many hundreds, with insulating material between the layers.

The dynamo current may have a potential of 500 to 600 volts and is transformed or converted by this apparatus into a current in the welding coil of less than one volt potential or pressure, but of enormous quantity, ranging from 2,500 to 3,000 ampéres. The pieces to be welded are simply brought in contact one with each of the terminals of the copper bar and held by thumb screws, while a hand-wheel and screw, or a moderate direct pressure brings the pieces together during welding and produces almost instantaneously a perfect weld. The amount of current required is exactly regulated by a switch connected with a set of resistance coils which regulate the power of the magnetic fields of the dynamo, and hence the amount of the current produced in the generator. No preparation of the metals is necessary and nothing is required except to bring them in contact while in the holder, before the current is turned on, although a little powdered borax is sometimes used as a flux at the point where the joint is to be made.

On passing the currrent through the pieces the heat at the point of contact rapidly rises until, with the exception of certain metals such as lead and steel, which require only a low welding heat, the metal seems fairly to boil and appears almost to melt, precisely as when a stick of sealing wax is held in a flame, and in three or four seconds time the weld is made, the current turned off and the bar rapidly cools off.

The current heats the whole section of metal uniformly because any cooler portion has a less resistance than the hotter portions, and therefore receives an increased amount of the current, which generates heat until the temperature becomes uniform with that of the rest of the cross-section.

The amount of energy in the welding circuit is very nearly equal to that of the current passing through the primary coil and the heat developed is proportional to the square of the current strength or volume and not to the tension or pressure of the current.

Heretofore the process of welding has been limited to wrought-iron and mild steel, since the heat required has destroyed the temper and burned out the carbon in high grade steel. But by means of this apparatus every metal which has yet been tried can be welded, from wrought-iron bars ¼ to 1¾ in. in diameter, steel, cast-iron, copper, brass, aluminum to platinum and iridium. Machines are now being built to weld bars from 2 to 3 ins. in diameter and pipes with butt joints end to end proportionately larger. Broken iron castings, such as part of printing presses and other machines, also brass castings have been welded with an increase of their original strength.

There is no danger connected with the process for the reason that the welding current is not of high enough potential to overcome the resistance of the human body. Indeed the writer saw a one-half inch bar welded with the operator's tongue placed across the terminals and it was stated that the passage of the current could hardly be tasted. The strength of the welds exceeds that of the pieces welded, for the joint is generally more or less upset by the pressing of the ends together during welding. Tools are made of wrought-iron with steel working edges, since the temper is drawn only locally and may be restored by retempering. Chains are made with two welds midway of the length of the links, which are made simultaneously. Rings on the end of bars are made by bending the ring to a circular form, leaving a space between the ends large enough for the rod to enter and the two welds are made simultaneously. Hoops and tires are welded with butt joints, the clamps taking hold on either side of the joint to be made, for since the heating will take place only at the point of greatest resistance the current does not sensibly heat the rest of the hoops, and the heat has time for conduction only for a short distance from the weld. Pipes can be welded throughout their length by the application of the same principle in a special machine and the strength is fully equal to that of the best lap welded joints. A portable welding machine may be used to weld pipe joints in the street, as the pipes are laid. The same principle, it is thought, will be applied to the welding of boiler plates, etc. The union of different metals is made with equal facility. All kinds of brazing is readily done, the only requirement being to make special holders for different shapes. A gold ring welding and brazing holder has its motions circular instead of rectilinear, and while it is itself a delicate apparatus it is used by simply attaching it to the holder of the large machine.

The power required is not excessive considering the short period of time during which it is required. A ¼-in. iron bar requires 800 to 1,000 ampéres of current, a ½-in. bar, 1,500 to 1,700 ampéres, at a potential not exceeding 1 volt, and this, at 746 volts to the horse power is equivalent to a power for a ½-in. bar of about 2.5 H. P., acting for the few seconds required. It is found that the power required for pieces of different sizes is nearly in proportion to the cross-sectional area. The power used varies during the welding process. As the heat increased the resistance to be overcome by the current also increases.

As to the two methods of welding, the direct method requires two conversions of the energy, viz.: (1), from the steam or mechanical power of the engine into the low potential but large quantity current of the dynamo; and (2), the conversion of this current into the heat by which the welding is done. The indirect requires three conversions, viz.: (1), from the mechanical power or work of the engine into the high potential alternating dynamo current; (2), the conversion from the high potential current to the low, in the induction or welding coil of the machine, and (3), the conversion of this current into the welding heat. The direct method will probably be used for heavy work and within short distances from the source of power, while the indirect may be best adapted for general purposes, where small machines are required at considerable distances from the dynamos. It is thought that present electric light plants may thus utilize their alternating current machines by supplying power during the day for these machines, in the various applications of the art.

The mention of some of the special advantages of the electric welding process will further explain what it does.

(1) There is absolute control over the heat. The metals can be held at any temperature desired by a number of means by which the current is controlled. One of these methods is by the simple moving of a lever which throws in more or less resistance.

(2) The heat can be watched and the process is visible all the time, as the pieces are not covered with coal and flames as in the ordinary process of welding. In welding, especially steel, a critical temperature exists at which a perfect weld is made. If the temperature is too low the molecules do not cohere, and if too high the carbon is burned out and consequently the steel can not be retempered. Electric welding is therefore the best process for steel requiring to be tempered after welding.

(3) The heating begins at the interior, and not on the exterior as in the ordinary process, so that if a weld is made on the outside we know it is perfect in the middle of the piece.

(4) The process is very rapid, iron bars being welded in less than 12 seconds time.

(5) The range of metals, or flexibility of the applications of the process is very great.

(6) The heat is localized at the point where the weld is to be made and the material is no where else heated.

(7) The economy or cheapness of the system is shown by the fact that no current is generated except when welding and there is no waste of power.

Incidental advantages are the saving of dirt, and especially of the time and labor of welding, as compared with former methods.

An important application which must not be overlooked is that of electric forging.

Shoulders and collars can be raised on bars, saving forging or turning down, and any desired shapes determined by dies. Both heads are quickly formed on bars in the same manner, the materia being heated, upset, and shaped by dies almost instantaneously.

Undoubtedly, electricity has a set of diseases peculiar to itself, but it would seem as though no serious difficulties could exist in comparison with the advantages and many useful applications of this art.

The Thompson Electric Welding Company, with which Prof. THOMSON is connected, have a factory beside the larger works of the Thomson-Houston Electric Co. at Lynn, Mass., with main offices at Mason Building, Boston, and devote themselves to the manufacture of welding machines, special holders and utensils adapted to welding requirements in other lines of business, and wherever their application may be advantages.

Suggestions as to Methods for an Approximate Determination of the Yearly Rental Value of Fire Hydrants, as Connected with any System of Water-Works.

BY J. NELSON TUBBS, MEM. AM. WATER-WORKS ASSOC'N.*

The popular notion among both engineers and laymen in relation to this subject seems to be, that the fair yearly rental value of a fire hydrant as connected with a particular system of water-works, is an indeterminate quantity. The great range of prices which obtains in the various towns and cities of the country, varying as it does from $15 to $125, is probably the result of this popular belief.

After considerable reflection, I am clearly of the opinion that this popular conception is entirely inaccurate. This remark I regard as especially true in relation to all water-works plants which have been intelligently constructed with a due regard to the relative requirements for domestic and fire uses.

Preliminary to the discussion of the proposed methods of determination, it may be premised, that this yearly rental value will vary with each plant and will also slightly vary with each series of years of greater or less length, dependent upon improvements and extensions made necessary by increased consumption of water and the growth of business interests to be supplied and protected.

The principal elements which enter into the determination of this question of values are as follows:

1.) A knowledge of the relations which exist between the maximum amount of water provided, under the plan of construction, for fire purposes, and the maximum amount provided for all other uses at the same moment. This determination of relations to be made not only as to the supply through the conduit, but also as to the distribution pipes through each street.

(2.) A knowledge of the relative amount of power required to furnish the maximum amounts of water for fire purposes and domestic uses, in the case of a pumping system, or of head in case of a gravity supply.

(3.) A knowledge, in case a reservoir or stand pipe is used, of the increase in capacity required, because of the fire protection.

(4.) A knowledge of the number, size and character of the fire hydrants and their branches and the specials and gates used in the fire provision.

(5.) A knowledge of the annual cost of superintendence of and repairs of the fire hydrants.

The intelligent water-works engineer, when called upon to design a water-works system, after having determined the *source* of supply, proceeds to inaugurate a careful inquiry into the question of maximum *volume* of supply required. This latter determination, in view of the almost phenomenal rapidity in growth of many American towns, is very largely problematical and its value will largely depend upon the experience, intelligence and sound judgment of the engineer; and whether the determination proves a correct one or not, it must be made.

The usual method is, by careful inquiry, and examination of the location and its natural advantages for business expansion, to arrive at a judgment of the probable eventual population and the character of the business enterprises to be most largely instrumental in the growth of the town in question.

When the probable maximum population at the end of 30 to 50 years is settled upon, it is further assumed that a domestic supply of from 60 to 100 galls. per capita per day is a fair and conservative provision, and the total daily supply is then for convenience stated in gallons per minute.

It is also probably safe to assume that one-half of said daily consumption will occur during eight hours. The whole system of pipeage must be adjusted to this maximum rate of domestic consumption.

The next subject of inquiry is the maximum quantity of water per minute which must be supplied for fire protection, and under what head.

To properly settle this question, a familiar knowledge of the character, number and situation of the manufacturing and other industries in the town is required, as on these depend the number, volume and power of fire streams required for protection.

Having settled upon the maximum number and character of the fire streams fairly required at any one time in any special locality and the resulting number of gallons of water per minute which will thus be used, this number of gallons per minute added to the maximum number of gallons per minute required for domestic use during the 8 hours of supposed greatest consumption, will constitute a fair determination of the maximum number of gallons per minute which must be supplied through the conduit. A further determination must also be made of the probable population and resulting domestic consumption in the various squares and main avenues of the town. This amount added to the required fire protection consumption as previously determined, will also determine the size of the several distributing mains.

The foregoing data being at hand, let the sum of the following items represent the increased cost of plant, its maintenance and operation because of the provision for fire protection:

(*a*) The excess in cost of conduit because of the necessity of seeking more distant sources of supply at greater elevations to make the fire service effective.

(*b*) The excess in cost of conduit, to include fire provision, from the point where a collecting reservoir might be located if a domestic supply only was desired.

(*c*) The excess in cost of the stand-pipe or reservoir because of the fire provision.

(*d*) The excess in cost of the distribution in the town itself because of the fire provision.

(*e*) The excess in cost of the specials used in the mains for hydrant branch connections over the same length of straight pipe, also including increased cost of setting and jointing same.

(*f*) The whole cost of the hydrant branches and laying same.

(*g*) The excess in cost of all gates and their setting in consequence of the increased size of the mains for the fire provision.

(*h*) The cost of all fire hydrants and their setting.

(*i*) The cost of the annual repairs of the fire hydrants capitalized at 5 per cent.

(*j*) Two per cent. of the cost of the fire provision as determined by the summation of items (*a*) to (*h*) inclusive, to cover cost of care and management of the fire plant and said 2 per cent. capitalized at 5 per cent.

(*k*) A sum, the accumulated interest of which, at 5 per cent. will produce the cost of the fire provision in, say 35 years, thus providing for its renewal at the end of that period.

(*l*) The excess in cost in case of a pumping plant, should be included in the items (*a*) to (*h*) inclusive, and the yearly excess in cost of operation should be capitalized at 5 per cent.

The annual interest on the gross sum of these several items, calculated at such a rate as capitalists are willing to receive for money loaned on good water-works securities in the particular locality in question, divided by the number of hydrants in use, may be said to approximately represent the yearly rental value of each of said hydrants.

When thus determined for a system of water-works intelligently designed, the yearly rental value of a fire hydrant will change very slightly, so long as the domestic consumption, including waste, does not exceed the amount contemplated by the original plan of construction.

It is a fact, much to be regretted, however, that very many existing systems of water supply have been designed by persons totally incompetent for such a duty, and many have been constructed on too small a pattern either because of a lack of means or the stupidity of the local management.

In such cases, the works when first constructed and before the domestic consumption has become large, may and in most cases do furnish water for fire protection in sufficient quantity and under a sufficient head for all practical purposes, but as the domestic use, with its concomitant waste increases, the volume and head for fire streams diminishes year by year, until the only value the system has for the latter purpose, is the possible furnishing of insufficient quantities of water to steam fire engines at convenient points for use.

In cases of this kind, a yearly determination of values should be made and the methods modified to the following extent:

Instead of seeking to determine the ultimate domestic consumption, the actual rate of such consumption at the date of the examination may be used until such time as the domestic uses have absorbed so much of the volume and head of water as to render necessary the intervention of steam fire engines and other appliances to supplement the volume, power and effectiveness of the streams at the hydrants, when some other method of determination will have to be adopted, the water works having then assumed a value for the extinguishment of fires but little in excess of the old street fire cisterns or reservoirs.

When the works have reached this condition, there should arise but little controversy in relation to values, and a determined effort should be made for a reconstruction of the system under the advice of an engineer of judgment and experience.

One other modification of conditions, may possibly be encountered in the experience of the engineer, and that is where, for some cause, the element of sufficient *head* for effective, modern fire streams has been deliberately neglected, but where an adequate *volume* for that purpose has been provided at each hydrant.

The writer can perceive no reason why the method of determination of the rental value herein before indicated, may not be applied in such a case.

If in the exercise of a wise discretion, the engineer shall conclude that the mere furnishing of an abundant volume of water at each hydrant, leaving the head to be supplemented by other appliances, shall prove of sufficient value to compensate for the increased cost of the works because thereof, there can certainly be no good reason adduced to prevent the application of the foregoing methods for determining values.

In such a case we are justified in the assumption, that the supplementing of the head at the hydrant by other appliances, is cheaper than that of providing the head in the original plan of construction.

The writer has had occasion to use the foregoing described methods of determination in the settlement of a controversy between a water works company and the citizens of a flourishing manufacturing village in the State of New York, in which the yearly rental paid for each fire hydrant had previously been $30, but which by this method of determination was reduced to $34.50.

The determination was finally accepted by both parties as a satisfactory solution of the problem of hydrant rental values.

This method had been applied and accepted in the granting of water works franchises in other towns where the plans had been fully settled, also in the determination in my own city of the allowance which should be made to the water works fund for public uses of water.

The method thus briefly stated is respectfully submitted for the consideration and criticism of the members of the Association.

That the foregoing method may be more readily followed and understood, I append the following illustration of its application to an assumed gravity supply the case being purely an ideal one.

ILLUSTRATION.

Assume a village situated on practically level ground, with 7 streets, each 100 ft. wide, running north and south and designated respectively, commencing with the most westerly, as A, B, C, D, E, F, and G Streets. Also 6 streets 100 ft. wide running east and west and designated respectively, commencing with the most northerly, as First, Second, Third, Fourth, Fifth and Sixth Streets, as indicated in the accompanying sketch. These streets divide the village into 30 squares, the sides of each being 500 ft. long.

It is further assumed that each square has, or will have, a population of 120, making a present or eventual total population of 3,600.

It is also assumed that at a distance of 5,000 ft. north of the north line of the village, a minimum supply of water equal to 375 galls. per minute, may be collected directly into a reservoir at an elevation of 200 ft. above the level of the town. Also that the same amount of water may be collected directly into a reservoir 125 ft. high, at a point 2,500 ft. north of the north line of the village, or midway between the town and the reservoir as at first assumed.

Under these conditions what would be the fair yearly rental value of each two way fire hydrant?

DETERMINATION.

3,600 inhabitants requiring, including all uses, an average of ..... = 360,000 galls. per day, or at the rate of 250 galls. per minute.	100 galls. each per day
Estimate ⅛ of this used in 8 hours, at the rate of.....	375 galls. per minute.
Estimate a provision of 6 fire streams at 150 galls. each, equal to.....	900 galls. per minute.
Making the maximum estimated requirement.....	1,275 galls. per minute.

The first assumed reservoir has an elevation of 200 ft plus the village, equal to a static pressure of 86.6 lbs. per sq. in.

To deliver at the north line of the village (a distance from the reservoir of 5,000 ft.), 1,275 galls. per minute through a 12-in. main, involves a friction loss of about 10 lbs. per sq. in., which deducted from the pressure 86.6 lbs. due to the head of the reservoir, leaves a working pressure at the hydrants at the intersection of the conduit with First Street of 76.6 lbs. per sq. in.

As the longest line of rubber 2½ in. hose required to be used at this point (with 1¼ in. nozzle) need not exceed 300 ft. the friction loss in the hose would be about 29 lbs., which deducted from 76 lbs. would leave an effective pressure at the nozzle of say 47 lbs. which would produce streams reaching about 120 ft. horizontal, and a vertical height of 90 ft.

Such streams would be regarded as sufficient for a town of the population assumed, and hence the size of the conduit may be fixed at 12 ins. diameter.

* Read at Cleveland Convention of the American Water-Works Association, April 17, 1888.

The next questions to be determined are, whether a reservoir placed at an elevation of 125 ft. would be high enough for domestic use in case the fire provision is abandoned, and if so, what should be the size of the conduit?

The second reservoir is assumed to be placed at an elevation of 125 ft. plus the village datum, equal to a static pressure of 54 lbs. per sq. in.

The friction loss in a 6 in. pipe 2,500 ft. long discharging at the rate of 375 galls. per minute is about 14 lbs., which deducted from 54 lbs. due to the elevation of the reservoir would leave an effective pressure at First Street of 40 lbs., equal to 92 ft. head, which would carry the water to the upper stories of all buildings, if provided with service pipes of reasonable size, and the conduit for a domestic supply may, therefore, be fixed at 6 in. diameter.

The excess in cost because of obtaining sufficient head for the fire service may be stated as follows, and designated as item (*a*):

2,500 lin. ft. 12 in. pipe = 94 tons at $34 delivered	$3,196
2,500 lin. ft. trenching for and laying 12-in. pipe and backfilling, at 36 cents	900
Amount of item (*a*)	$4,096

The excess in cost because of increased size of the conduit for the fire service from the second or lower reservoir to the town, may be stated as follows, and designated as item (*b*):

Difference in weight of 12-in. and 6-in. pipe 2,500 ft. long = 57 tons at $34	$1,938
Difference in cost of laying 12-in. and 6-in. pipe 1,500 ft. long = 2,500 ft. at 8 cents	200
Amount of item (*b*)	$2,138

The next question to be considered is, to what extent the size and cost of the reservoir is to be affected by the addition of the fire provision.

In the case assumed, the minimum flow of the collected water is placed at 375 galls. per minute, while the average requirement for the whole 24 hours is at the rate of 250 galls. per minute. It follows that for the domestic supply only, a very small and comparatively cheap reservoir may be designed and safely employed, say with a capacity of 100,000 galls. or less.

The fire provision must, however, be provided from stored water, and the minimum amount thus stored must equal 900 galls. per minute during the continuance of a fire.

In a manufacturing town a single fire may require fire streams for a period of at least 4 hours, and it is not impossible that three such fires should occur within a period of 24 hours. This would require a storage as follows: 900 galls. per minute for 12 hours or 720 minutes, equals 680 000, say 700,000 galls., to which add 100,000 galls. for domestic storage, and we reach the conclusion that we require a reservoir of a storage capacity of 800,000 galls. when we include the fire provision, as against one of 100,000 galls. of the domestic system alone.

The determination of the difference in cost of the two reservoirs is not difficult, and therefore for our present purpose we will assume the amount of this difference in cost and designate the same as item (*c*):

Excess in cost of reservoir because of fire provision (item *c*)	$3,500

We will now proceed to the determination of the increased size and consequent cost of the pipe distribution because of the fire provision; and to illustrate will take the case of the main in First Street, or the most northerly street in the village and which is 3,700 ft. long and intersects the conduit at "D" Street.

At the northwest corner of the village at the west end of First Street, and at a distance of 1,850 ft. from the intersection with the conduit at "D" Street, it is required to furnish as follows:

6 fire streams each discharging 150 galls. per minute =	900 galls. per min.
A domestic supply to 300 people = 30 galls. per minute	30 " "
Total maximum required at that point	930 " "

The friction loss in a 10-in. pipe 1,850 ft. long under these conditions is about $5\frac{2}{10}$ lbs., which will give practically the same character of fire streams as at the corner of "D" Streets where the 12-in. conduit first reaches the North line of the town, especially so in case any less than 6 streams should be used at once.

By a similar calculation we might determine the size of main required for each of the two systems.

We will assume for the sake of brevity that this has been one with the following results:

Sizes of Mains Required for the System Including the Fire Provision.

First and "D" Streets	10 in. diam.
Sixth, A and G Streets	8 " "
Second, Third, Fourth, Fifth and B, C, E, and F Streets	6 " "

Sizes of Mains Required for the Domestic Supply Alone.

Second, Fourth, Sixth and "D" Streets	6 in. diam.
First, Third, Fifth, A, B, C, E, F and G Streets	4 " "

On making the necessary combinations, we find that the distribution which provides a fire protection will require a weight of straight pipe 236 net tons in excess of the domestic system, and about 6,000 lbs. of special castings.

A detailed calculation will also show that the laying, jointing, etc., of the first system will cost about $900 in excess of the second.

The following statement includes these several items and indicates the excess in cost of the village distribution because of the fire provision, and may be designated as Item (*d*).

ESTIMATE.

236 net tons straight pipe at $34	$8,024
6,0 0 lbs. specials (estimated) at 3 cents	180
Excess in cost of laying pipe	900
Amount of Item (*d*)	$9,104

The assumption is made that the town in question will require 50 hydrants, and Item (*e*) will represent the excess in cost of hydrant branch specials and cost of jointing, etc., over the same length of straight pipe.

ESTIMATE.

10,760 lbs. specials for hydrant branches, at 3 cents	$321.00
Extra cost of setting, jointing, etc., over straight pipe	100 00
Amount	$421.00

DEDUCT.

4,000 lbs. straight pipe saved, at $1\frac{7}{10}$ cents	$68 00
Amount of Item (*e*)	$353 00

Item (*f* includes whole cost of hydrant branches and laying same.

10 net tons straight pipe at $34	$340.00
1000 lin. ft. trenching and laying at 26 cents	260.00
Amount of Item (*f*)	$600.00

Item (*g*) embraces the increased cost of valves, required in consequence of the increase in the size of the distribution mains required for the fire provision. As these can easily be exactly determined, I simply assume an amount for my purpose of illustration.

Excess in cost of gates and setting, Item (*g*)	$500.00

Item (*h*) includes the cost of all fire hydrants and setting

ESTIMATE.

50 two-way fire hydrants at $30	$1,500.00
setting 50 fire hydrants at $4	200.00
Amount of Item (*h*)	$1,700.00

The summation of preceding items makes the cost of fire provision	$21,991.00
Item (*i*) is the capitalization of the yearly cost of repairs to fire hydrants as follows: 50 hydrants at $3 = $150 ÷ 5 cents =	3,000.00
Item (*j*) is the capitalization of the yearly cost of care and management of the fire plant, as follows: The cost of plant = $21,991 × 2 per cent. = $439.82 ÷ 5 cents.	8,796.00

Item (*k*) is a sum, the accumulated interest of which, when compounded at 4 per cent. will, in 35 years, amount to the cost of the fire provision plant and also repay the original sum at the end of the period, as follows:

Formula $S = \frac{1}{1.04^n - 1} \times P$. In which S = sum which will, at end of 35 years, at 4 per cent. produce $(S + P)$.

P = original cost of fire plant,

n = number of years in which plant is to be renewed,

This formula becomes $S = \frac{1}{1.04^{35} - 1} \times \$21,991$ 7,405.00

Total investment required to construct, maintain, manage, and renew the fire provision $41,252.00

As water-works bonds can readily be sold at from 3½ to 5 per cent., using the larger rate we have $41,252 × 5 per cent. = $2,062.60 yearly interest on same, which must be paid from fire hydrant rental.

$2,062.60 ÷ 50 hydrants equals $41.25 per year as the *rental value of each hydrant in the case assumed.*

Construction of Reservoir and Dam at Athens, Ga.*

I do not intend to go into the theory of the dam in giving a brief description of the reservoir built at Athens, Ga., in 1883, beyond stating that the safety factor was five and its stability was calculated by moments.

The source of the water is springs at the head of the valley and their flow was measured by a weir and calculated by the following formula:

$$Q = 3.33\,(L - 0.2\,h)\,h^{\frac{3}{2}}$$

Q = Cubic feet per second; L = length of weir in feet; h = depth of water flowing over weir in inches.

The reservoir is located at the mouth of a small valley about a mile long enclosed by low hills. The character of the materials, the sudden disappearance of the rock in the center, and the hill running across the head, giving the form of an amphitheatre, shows that the valley must have been formed by some convulsion at an early period.

The construction was as follows: We first located the center line of the dam, and sounding along the western slope we found rock at a depth varying from 3 to 5 ft.; as we sounded down the slope and passed the bed of the creek, the rock broke abruptly off, neither was there any trace of it at a depth of 15 ft., nor for a distance of a 100 ft., when we suddenly came upon it again at a depth of 6 ft. and continued to find it up the east slope of the valley at a depth varying from 4 to 6 ft.

The material developed at the portion of the center line where the rock disappeared was blue clay. This formation enabled us to tell just how deep it was necessary for the foundation of the dam to be in order to prevent water from leaking under it, the materials we had to deal with and how to arrange them in their proper order. The materials found were soil, red and blue clay, gravel and rock. We first removed the surface soil 200 ft. back from the center line and deposited it on the back of the dam with scrapers. We then cut a trench 6 ft. deep and 9 ft. wide (see Fig. 3, showing foundation line), which was carried across the valley and up the east slope of the hill. On this side, half way up the hill we found a seam running at about an angle of 60° with the center line. When the clay and loose rock had been removed to the required depth it proved to be a spring, which was stopped in the following manner: The seam was about ¾-in. wide. We had all the earth removed both ways until we passed the footings on both sides of the dam; we then put ¾ in. pine wedges in and drove them down 5 ins. below the surface, and in 24 hours they were swollen in tight; we next had some clay kneaded up and rolls made of it with hemp centers, this was well packed in to a depth of 2 ins.; on this we put ½ in. of dry sand and then ran in 1-in. of lead, had it well caulked and filled up with grout made of Portland cement. We had hardly finished when a spring broke out at the very end where the running in of the lead was stopped, but being outside of the dam it did no damage. (The reason I used lead was that as I could get in such a small quantity of grout, it would only be a matter of a short time before the water worked its way between the rock and cement.)

The priming wall was now started so that its front face came exactly under the front angle of the top of the dam, and was built of hard brick, laid in cement of the following thickness: 20 ins. for 2 ft., then reduced to 16 ins., from 16 ins. to 12 ins., from 12 ins. to 8 ins. As it was carried up, a puddle wall, 2 ft. thick, of blue clay, was made in front of the priming wall; the main puddle wall at the back was also made of blue clay, 5 ft. 4 ins. thick, until the surface of the ground was reached, when it was increased to 9 ft. 4 ins. thick, the puddle then being reduced in thickness as the height increased, first to 7 ft. 4 ins., then to 5 ft. 4 ins. at the top. These two puddles were made entirely of blue clay, in 6 in. layers, and rammed into a solid mass (see Fig. 1). The back section of the dam was made of soil and red clay, mixed together and spread in 8-in. layers, wet and rammed. The front slope was made entirely of red clay, spread in 8-in. layers, and well puddled. The back slope was then carefully sodded, and the front slope covered with 6 ins. of small broken stones and coarse gravel, rolled very hard with a 2-ton roller.

We next cut the footing for the rip-rap, and put in a block of concrete 3½ ft. × 5 ft. The rip-rap was carefully laid, and then a thin grout poured over the entire face and swept in all the cracks. No stones were used in the rip-rap smaller than 4 in. × 10 in. + 12 in.

The waste weir is on the east side of the dam, and built as follows: We cut down a section of the dam 4 ft. below the top and put in 1½ ft. of concrete over the entire bottom of the section 10 ft. wide; it was then paved with brick laid in cement and a 12 in. wall carried up on each side, with wings running out beyond the slopes of the dam. Across the back a 12-in. brick wall was built, through which runs a 20-in. waste-pipe that can be closed just before the dry season and give an additional storage of 2 ft.

During the construction the water of the creek was passed under the dam through a 20-in. pipe, and at every 8 ft. on this pipe little shafts 12 in. in diameter were carried up until they came above

*A paper read before the Engineers' Club of St. Louis. BY CHARLES H. LEDLIE.

grade; their use will be explained hereafter. The inlet tower and pipes were then put in (Fig. 2), the tower being provided with a screen and slide valve (to be used in case of repair). We used a large special with 3 flanges 6 in. wide, through which the inlet pipe was passed and leaded in. This special was built into the brick-work of the priming wall, thus preventing the water from following the pipe, which is often the case and causes much damage.

The inlet tower is reached from the top of the dam by means of a small bridge 2 ft. wide and 50 ft. long. (See Fig. 4, broken line shows original surface, full line shows depth excavation was carried down; also shows section of reservoir). Fig. 4 also shows the embankment at head of reservoir called the neck, plainly showing the manner in which it was built. A small dam was built across the head of the neck as shown in the section of the reservoir (Plate 4 or 5). The water passed into the neck from the creek through four 6-in. pipes. Over the mouth

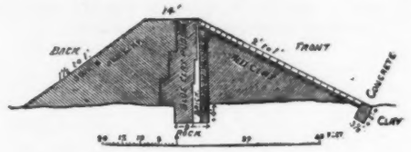


Fig. 1. Section of Dam.

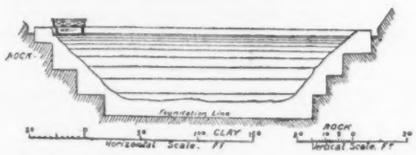


Fig. 3. Mean Section of Reservoir.

each pipe there was placed a screen as well as automatic valves, which are always used in rainy weather in order to keep out the muddy water. The dam at the head and neck was built to raise the creek water, so as to pass it round the reservoir in the large ditch, cut for that purpose on the west side of the hill, and to keep the water from settling back over the adjoining land. (Plate 5 shows general plan of reservoir complete).

The reservoir is protected on all sides by storm ditches. The small dam at the head of the neck was not built until the 20-in. pipe passed under the large dam was closed. The pipe was stopped in the following manner:

A small coffer dam was made in (3) sections to fit the slope (see Fig. 6), and a good water-tight joint made around it. The water inside was then allowed to run out, and a large tarpaulin, weighed down with stone, was spread under the mouth of the pipe and carried up the sides of the coffer dam, giving a perfectly tight joint. The mouth of the pipe was closed with brick laid in cement. Next shaft No. 1, was filled with concrete to grade (the size of the stone not to exceed ¾ in. in diameter). Shaft No. 2, was filled with sand; No. 4, was also filled with sand, and No. 3, was then run full of grout and so on until all were filled, and lastly the end of the pipe was closed with brick laid in cement.

The coffer dam was taken out after the cement had been allowed 24 hours to set, and the pipe was found to be perfectly tight. Then we built the little dam at the neck, on the same principle as the large dam. The entire bottom and sides of the reservoir were covered with white gravel to a depth of 4 in. (the gravel being found principally in pockets in the excavation and from gravel pits near by) after being

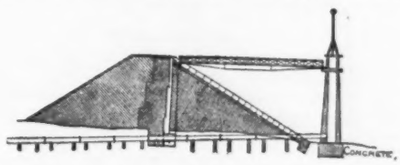


Fig. 2. Section of Dam, Inlet Tower and Pipe.

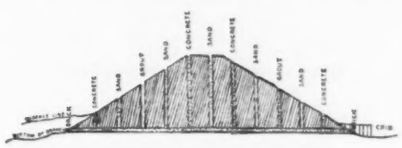


Fig. 6. Section through Branch.

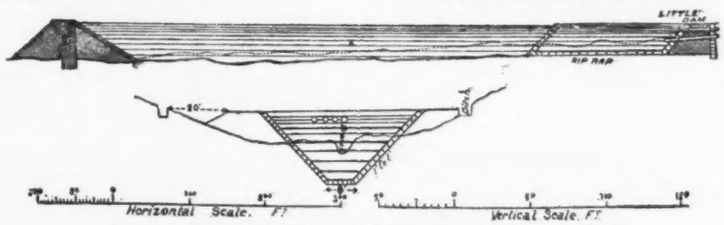


Fig. 4. Longitudinal Section of Reservoir and Section of Neck.

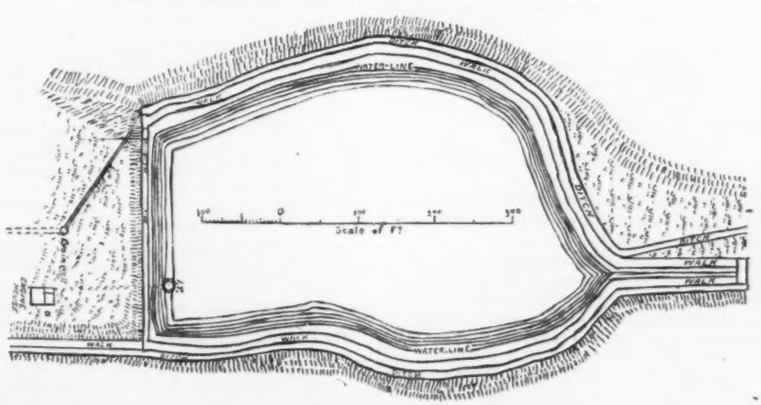


Fig. 5. Plan of Reservoir.

RESERVOIR AND DAM AT ATHENS, GA.

The reservoir filled in 30 days, and from 50 weir measurements, I found the flow (the time being the fall of the year) varied from 750,000 to 800,000 galls. per day, giving a capacity of about 22,000,000 galls., one million more than was originally calculated for; to which can be added 2 ft. additional storage at any time.

In closing this paper I wish to call attention to a few things that I have noticed about several storage reservoirs I have had occasion to examine of late. The designer failed in each case to carry the foundation of the puddle wall deep enough, and water leaked under the dam, in the tying in the ends, in the footing for the rip-rap, in preventing the wash of the back slope from rains by sodding, in arranging the materials properly, and especially in puddling, which I have noticed the engineer trusted to doing by the passing of a heavy roller, or the tramping of cart horses over the layer once or twice in bringing their loads, considering that sufficient for making the puddle wall; and in not protecting the sides of the reservoir with storm ditches, letting the contractor put in all sizes of stones in the rip-rap. A great many prominent engineers say, "priming walls of stone or brick are useless. Give a crawfish or a muskrat a few feet of soft digging and it will stop when it comes to the hard puddle", all of which is very true if the rat and crawfish have been properly educated, which is rarely the case, however. I know of two storage reservoirs in the South where the dams have broken away, one caused by muskrats and the other by crawfish; both were built by the same engineer, and on the supposition that these animals stop digging when they come to the hard clay puddle. From my own experience I offer this bit of perhaps "poor advice": wherever you have muskrats or crawfish, do not leave out a priming wall; even if it is only 4 ins. thick, it is better than nothing, for if you leave it out it is only a question of time before you are sorry you did so.

And one other thing before closing: I have frequently noticed that little or no attention is paid to the flow of water into a storage reservoir as regards protecting the inlets from all sorts of rubbish that comes down the stream passing in and settling into it, or of providing means of throwing this water round the reservoir when you want to clean or repair it.

I believe if engineers would pay more attention to the few points mentioned above, which are very old in practice, but sadly neglected nowadays, they would have less trouble and save themselves the mortification of other engineers going in a few years and repairing practically their new work, which has gone to pieces, for no other reason than carelessness when constructed.

A CORRESPONDENT of *Indian Engineering* in a criticism of the Hooghly cantilever bridge makes the following general comments on a defect of English bridge building:

"Another point where English practice differs for the worse from American, is in the wind bracing. This is always adjustable in America, and never in England, even between the compression chords, so that bracing put in before the bridge is swung must be slack when the chord is compressed by the load, unless it has received an initial tension equal to the future compression of the chords and this cannot be given by drilling the rivet holes with a "draw" even if it is supposed to be done, for the only result of that arrangement is to enlarge the rivet holes in drifting them up.

I am very sure that had most of the large bridges in this country been open to tender from any country, to include design and cost of erection, very few of them would have come from England."

QUICKSANDS have caused a great deal of trouble in the construction of the railway lines between western Kansas and the Rocky Mountains. They are said to be found in every stream, however small. Pile driving was first tried, but the longest piles failed to touch the bottom. Filling with earth and stone met with equally poor success, and the only expedient which proved successful was to build short truss bridges, which greatly increased the expense. As an instance showing the nature of these quicksands, it is said that a heavy freight locomotive fell into one of them and entirely disappeared in twenty minutes. Two days later a careful search was made with magnetized rods, which were sunk 65 ft., but no engine could be found.

THE first railway constructed in Japan was opened in 1872. It connects Tokio and Yokohama, and is now the only two track line of railway in the country. The latest records are that at present there are 598½ miles of railway open, 254 miles in course of construction, and about 700 miles contemplated.

Drainage Tables.*

BY GEORGE H. JOHNSON, C. E., S. B., Lincoln, Neb.
B. & M. R. R. R.

The following problem is proposed:

To find the diameter, d, of a pipe of given length, l, which will discharge Q cubic feet of water per second under a head of h feet.

Suppose, moreover, that we have given the drainage area in acres $= A$; and the maximum available rainfall in inches per hour $= a$ on the given area.

The available rainfall per hour at any cross section of the drainage basin is defined to be the volume of water which flows through that section per hour; hence, it is generally much less than the total rainfall per hour on the area drained.

It is evident that the maximum available rainfall depends upon many circumstances, and the question of determining its amount will not be considered here. Suppose, however, that this quantity, which we denote by Q, has been determined or assumed. Since 1 in. of rain on one acre amounts to 3,630 cu. ft. we always have

$$Q = \frac{3{,}630}{60 \times 60} A\, a \qquad (1)$$

cu. ft. per second.

Table I has been computed from this equation by assuming $a = \frac{1}{4}$, and then assigning different values to A.

The discharge varies directly with the product $A\,a$; hence if we wish to assume $a = 2\,(\frac{1}{4}) = \frac{1}{2}$ we shall find the corresponding Q opposite $2 \times A$, and so on.

TABLE I.

Showing amount of water discharged per second with an available rainfall of ¼ in. per hour.

Drain. area in acres $=A$	Cu. ft. $=Q$	Drain. area in acres $=A$	Cu. ft. $=Q$	Drain. area in acres $=A$	Cu. ft. $=Q$	Drain. area in acres $=A$	Cu. ft. $=Q$
50	12.6	3200	807.	16000	4033.	38000	9578.
100	25.2	3600	908.	18000	4537.	40000	10083.
200	50.4	4000	1008.	20000	5042.	45000	11343.
400	100.8	5000	1260.	22000	5546.	50000	12604.
600	151.3	6000	1512.	24000	6050.	55000	13864.
800	201.7	7000	1765.	26000	6555.	60000	15125.
1200	302.5	8000	2017.	28000	7058.	70000	17646.
1600	403.3	9000	2269.	30000	7562.	80000	20167.
2000	504.1	10000	2521.	32000	8066.	90000	22687.
2400	604.9	12000	3025.	34000	8570.	100000	25208.
2800	705.7	14000	3529.	36000	9074.		

We resume the consideration of the problem proposed.

Let z_o denote the coefficient of resistance at the orifice of the pipe, and let z denote the coefficient of friction in the pipe.

Experiments have shown that the friction in the pipe is independent of the pressure, and nearly proportional to $\frac{l}{d} z$. If we measure this resistance by the height of a column of water h_1, which must be subtracted from the total head h, in finding the virtual head, we have

$$h_1 = z \frac{l}{d} \frac{v^2}{2g}.$$

Similarly, for the resistance at the orifice

$$h_o = z_o \frac{v^2}{2g}.$$

Hence,
$$h = \left(1 + z_o + \frac{l}{d} z\right) \frac{v^2}{2g}, \qquad (2)$$

and
$$v = \frac{\sqrt{2gh}}{\sqrt{1 + z_o + z\frac{l}{d}}} \qquad (3)$$

If the cross-section of the pipe is a rectangle, whose height is a, and whose width is b, we must substitute,

$$d = \frac{\pi d^2}{\pi d} = \frac{4 \times \text{area}}{\text{periphery}} = \frac{2ab}{a+b};$$

whence
$$h_1 = z \frac{l(a+b)}{2ab} \cdot \frac{v^2}{2g}, \qquad (2, a)$$

and
$$v = \sqrt{\frac{2gh}{1 + z_o + z\frac{l(a+b)}{2ab}}} \qquad (3, a)$$

We shall assume that the pipes are of cast-iron, laid horizontally under embankments which are 15 ft. wide at the top with slopes of 1½ to 1. Hence, if H is the height of the embankment, we shall have

$$l = 15 + 3H \qquad (4)$$

*Copyright, 1888, by GEO. H. JOHNSON.

We also assume that the pipes are circular, the thickness at the orifice being not less than ⅛ of the internal diameter, and the inside not rounded off.

If the pipes are rounded off at the orifice the coefficient of influx will be considerably increased; but experiments show that if the thickness is less than ⅛ the diameter, and the pipe projects into the reservoir the coefficient will be decreased, owing to the loss of energy in the moving fluid. A similar decrease will be caused by cutting off the pipe in the plane of the inclined embankment.

In practice, since the bell-end of the pipe is always put up-stream, the increase in the influx resulting from the enlarged orifice will at least compensate for the decrease due to the projection of a thin pipe into the reservoir.

For straight pipes such as we assume we have, according to WEISBACH, $z_o = .505$; and according to DARCY $z = .02$. Substituting these values in (3) we have

$$v = \sqrt{\frac{2gh}{1.505 + \frac{l}{d}.02}}$$

It is evidently necessary to know v before we can find d; but v itself is a function of the unknown quantity d, and hence we can proceed only by successive approximations. But when the head of water is 4 ft. or over, and the ratio $\frac{l}{d}$ is known approximately, we can find immediately a near approximation to the actual velocity.

For example, having given $Q = 100.8$; $h = 16$; $l = 63$; $25 < \frac{l}{d} < 29$; it is required to find v and d.

Assuming $\frac{l}{d} = 27$ we have

$$v = \sqrt{\frac{64.4 \times 16}{1.505 + .540}} = 22.45 \text{ ft. per second as a first approximation.}$$

Again,
$$v = \frac{Q}{\text{sectional area}} = \frac{4\,Q}{\pi\, d^2};$$

whence
$$d = \sqrt{\frac{4\,Q}{v\,\pi}} \qquad (5)$$

Substituting for v its approximate value we obtain

$$d = 1.128 \sqrt{\frac{100.8}{22.45}} = 2.50 \text{ ft.},$$

which is nearly correct since it gives $\frac{l}{d} = \frac{63}{2.5} = 25.2$.

A second approximation will give us $d = 2.47$.

Experiments made by M. DARCY show that when the pipes are old and incrusted the coefficient of friction is greatly increased. For such a pipe it would be safe to assume $z = .04$;

whence $1 + z^o + \frac{l}{d} z = 1.505 + 1.08 = 2.585$, when $\frac{l}{d} = 27$. Substituting this value in (3), and taking h and Q as before, we obtain as the first approximations $v = 20.0$, $d = 2.62$.

It is the custom of engineers to add an inch or less to the computed diameter as an allowance for incrustation; but for a long pipe it is evident that an additional allowance should be made in consideration of the increased friction in an old pipe. As the ratio $\frac{l}{d}$ increases this change in resistance becomes very important.

In the above example we assumed an exact value for the average head. But in designing drainage pipes, even when the height of water above the bottom of the pipe is known exactly, the average head is known only approximately unless the external orifice is in a horizontal plane.

As a first approximation we may assume that the total head h, is the vertical distance between the level surface of the water and the center of gravity of the external orifice. This assumption, however, involves a double error. First it supposes a knowledge of the unknown diameter, d. Second, it assumes that the mean head at the orifice will produce the average velocity of discharge. Both errors are insignificant when the ratio $\frac{d}{h}$ is small.

When the head at the center of gravity of the external orifice is less than the diameter we should consider separately the particles of water in each horizontal layer of infinitesimal thickness.

By a double integration we obtain as the corrected value of the velocity of water in a circular horizontal pipe whose orifice is in a vertical plane

$$v' = v\left[1 - \frac{1}{32}\left(\frac{d}{2h}\right)^2 - \frac{d}{1024}\left(\frac{5}{2h}\right)^4\right] \qquad (6)$$

For example, if we have given $Q = 11343$; $h = 16$; $l = 63$; we find by (3) and (5) $v = 25.74$, $d = 23.69$. Applying the correction in equation (6), we have $v' = 25.74 \times .0824 = 25.27$; whence $d = 23.90$.

This correction has been made in the computation of Table IV.

To facilitate the computation of the diameters required, we may use Tables II and III to find approximate values of the velocity.

Table II gives the theoretic velocity $v = \sqrt{2\,g\,h}$ on the assumption that there is no friction.

Table III gives the approximate coefficient of discharge by which the theoretic velocity must be multiplied to obtain the actual velocity.

TABLE II.

Theoretic Velocities in Feet per Second.

h	$\sqrt{2gh}$	h	$\sqrt{2gh}$	h	$\sqrt{2gh}$	h	$\sqrt{2gh}$	h	$\sqrt{2gh}$
1	8.03	8	22.7	20	35.9	32	45.4	44	53.2
2	11.4	10	25.4	22	37.6	34	46.7	46	54.4
3	13.9	12	27.8	24	39.3	36	48.1	48	55.6
4	16.0	14	30.0	26	40.9	38	49.5	50	56.7
5	17.9	16	32.1	28	42.5	40	50.7	60	62.1
6	19.7	18	34.0	30	43.9	42	52.0	70	67.1

TABLE III.

Coefficients of discharge $= \frac{1}{\sqrt{1 + z_o + \frac{l}{d} z}}$, where $= .505$ and $z = .02$

$\frac{l}{d}$	Coef.	$\frac{l}{d}$	Coef.	$\frac{l}{d}$	Coef.	$\frac{l}{d}$	Coef.	$\frac{l}{d}$	Coef.
4	.79	12	.76	18	.73	27	.70	36	.67
7	.78	14	.75	20	.72	30	.69	40	.66
10	.77	16	.74	24	.71	33	.68	50	.63

The approximate value of $\frac{l}{d}$ must be found in the first column, and the corresponding value of the coefficient will be found opposite in the second column.

Using the preceding tables and formulas, and making successive approximations, we have computed Table IV., which shows the diameters of circular pipes required to discharge Q cubic feet of water per second under a given head. The head, measured from the level surface of the water to the center of gravity of the orifice, will be found in the left-hand column, Q at the top of each column and the corresponding d—in feet—at the intersection of the horizontal and vertical lines through those quantities.

TABLE IV.

Diameter of Circular Pipes Required to Discharge 2 cu. ft. of Water per Second, when $l = 15 + 3h$, $z_o = .505$ $z = .02$.

Head	$Q =$							
	12.6	25.2	50.	100.8	151.3	201.7	302.5	403.3
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
4	1.21	1.68	2.34	3.32	3.94	4.58	5.53	6.42
6	1.12	1.54	2.15	3.05	3.62	4.19	5.13	5.85
8	1.06	1.46	2.01	2.85	3.37	3.89	4.78	5.40
10	1.02	1.40	1.91	2.72	3.22	3.66	4.47	5.07
12	.99	1.36	1.85	2.62	3.09	3.50	4.22	4.88
14	.96	1.32	1.82	2.54	2.99	3.38	4.07	4.61
16	.94	1.29	1.76	2.46	2.91	3.30	3.98	4.58
18	.93	1.27	1.72	2.38	2.84	3.24	3.87	4.48
20	.92	1.25	1.69	2.34	2.79	3.19	3.78	4.40
22	.91	1.23	1.68	2.31	2.72	3.14	3.72	4.32
24	.90	1.22	1.66	2.29	2.68	3.10	3.67	4.25
26	.90	1.21	1.65	2.27	2.66	3.06	3.62	4.18
28	.89	1.20	1.64	2.25	2.63	3.02	3.58	4.12
30	.88	1.19	1.62	2.23	2.61	2.98	3.54	4.06
32	.88	1.18	1.61	2.21	2.59	2.96	3.50	4.01
34	.87	1.17	1.59	2.19	2.57	2.93	3.47	3.96
36	.87	1.16	1.58	2.18	2.55	2.90	3.44	3.92
38	.86	1.15	1.57	2.16	2.53	2.88	3.41	3.88
40	.86	1.15	1.56	2.14	2.51	2.86	3.38	3.85
42	.85	1.14	1.55	2.13	2.50	2.84	3.35	3.83
44	.85	1.13	1.54	2.12	2.49	2.82	3.33	3.81
46	.84	1.13	1.53	2.11	2.47	2.81	3.31	3.79
48	.84	1.12	1.52	2.09	2.46	2.79	3.29	3.77
50	.83	1.12	1.51	2.08	2.44	2.77	3.27	3.76

Head	Q =									
	504	605	706	807	908	1008	1260	1512	1765	2017
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
4	7·2	7·9								
6	6·5	7·2	7·8	8·1	8·5	9·1	10·2	11·2		
8	6·0	6·6	7·2	7·6	8·1	8·4	9·4	10·3	11·2	11·9
10	5·7	6·2	6·7	7·2	7·6	8·0	9·0	9·8	10·6	11·3
12	5·4	6·0	6·4	6·8	7·2	7·7	8·6	9·4	10·2	10·9
14	5·3	5·8	6·2	6·6	7·0	7·4	8·3	9·1	9·8	10·5
16	5·1	5·6	6·0	6·4	6·8	7·2	8·0	8·8	9·5	10·1
18	5·0	5·5	5·9	6·3	6·7	7·0	7·8	8·6	9·2	9·8
20	4·9	5·4	5·8	6·2	6·5	6·9	7·7	8·4	9·0	9·6
22	4·8	5·3	5·7	6·0	6·4	6·7	7·5	8·2	8·9	9·4
24	4·7	5·2	5·6	5·9	6·3	6·6	7·4	8·0	8·7	9·3
26	4·6	5·1	5·5	5·8	6·2	6·5	7·2	7·9	8·6	9·1
28	4·6	5·0	5·4	5·7	6·1	6·4	7·1	7·8	8·4	9·0
30	4·5	4·9	5·3	5·6	6·0	6·3	7·0	7·7	8·3	8·8
32	4·5	4·9	5·2	5·6	5·9	6·2	6·9	7·6	8·2	8·7
34	4·4	4·8	5·2	5·5	5·9	6·1	6·8	7·5	8·0	8·6
36	4·4	4·8	5·1	5·5	5·8	6·0	6·8	7·4	7·9	8·5
38	4·3	4·7	5·1	5·4	5·7	5·9	6·7	7·3	7·8	8·4
40	4·3	4·7	5·0	5·4	5·7	5·8	6·6	7·2	7·8	8·3
42	4·3	4·6	5·0	5·3	5·6	5·8	6·5	7·1	7·7	8·2
44	4·2	4·6	5·0	5·3	5·6	5·7	6·5	7·1	7·6	8·2
46	4·2	4·6	4·9	5·2	5·5	5·7	6·4	7·0	7·6	8·1
48	4·2	4·5	4·9	5·2	5·5	5·6	6·4	7·0	7·5	8·0
50	4·2	4·5	4·9	5·2	5·4	5·6	6·3	6·9	7·4	7·9

TO BE CONTINUED.

An Electric Pumping Plant.

In the large cities of this country the ordinary pressure of the public water supply is rarely ever sufficient to elevate the water to the upper stories of dwelling houses, stores or factories. The usual method of obtaining water above the second or third story is to pump it to a tank on the roof of the building or immediately under it. This is done either by hand, by a windmill, or by a small pumping engine. This last has usually been driven by steam, gas, or hot air, and the application is familiar to everybody. A steam engine, a gas engine, or a hot air engine has to be "fired up" before it will do any work, and either must be looked after or there is a chance for an accident. The best of the caloric engines will be noisy and where gas is used, the smell is a very pronounced factor. The receiving tank is usually a heavy box on account of the necessity of its being capable of storing a considerable quantity of water; the supply is indicated by a gauge which tells when to start up the pump to replenish the quantity. Where much water is used constant watchfulness is demanded.

The application of electricity to pumping brings relief to every householder, merchant and manufacturer who desires a constant supply of water without having to give the subject attention himself or through a servant.

As in the case of placing a telephone or a telegraph instrument in one's house, so with the electric pump, connection is made with the nearest electric lighting circuit: the pump occupying about 24 sq. ins. of space, and as ornamental as a clock, and no noisier, may be placed anywhere so that it is connected with the well or reservoir from which water is to be taken; the house is piped to a tank on the upper floor as is usual, or it may be placed on the cellar floor and the water forced up; a week's supply of oil is given, and the pump is ready. An ordinary ball float serves all the purposes of the best trained servant. When the water is drawn down in the tank one or two inches as provided for, the ball drops and closes the electric circuit; the pump, driven by an electric motor of such power as is provided for the service demanded, commences at once to refill the tank and it will not stop until the normal level has been regained, when the float immediately cuts the circuit and the pump stops. It is as automatic as a machine can be. The parts of the whole apparatus are so few and so simple that they cannot get out of order: the wear is so slight that for years it will not be appreciable; there is no disagreeable noise and absolutely no odor from it as from gas: there is not the least danger from shock, as the amount of electricity required to drive the largest sized pump required for domestic use is scarcely appreciable in handling the wires.

The first successful electric pump, so far as we can ascertain by investigation, is the invention of A. E. HALL, of Plainfield, N. J., well known already in connection with the Hall Duplex Pump, and it is now in the market. It is specially adapted for use in city residence, stores, factories, flats, hotels or other high buildings where the public water supply does not reach to the upper floors: it is adapted for use in isolated country residences, where a small electric plant is in use for lighting the house and grounds: it may be used for fire protection, and where the electricity is always on, it is ready for use on the instant—turning on the water gives the supply and the pressure at once; lawns and gardens, stables and outhouses, fountains on the lawn or in the house: all may be supplied by the electric pump at a minimum of expense, without noise and without attention.

The use of electricity is becoming so general that the field is already a broad one, and we may reasonably expect that the electric pump has come to take its place among the many wonderful applications of the Electric Motor.

The main office of the Hall Electric Pump Co. is in Plainfield, N. J.: the New York office is at 105 Tribune Building. Prices and further information may be had on application at either address.

The Bournemouth Direct Railway.

An article in *The Engineer* gives a description of a rather curious and notable bit of railway between Christchurch and Brockenhurst, 10 miles long, and opened March 5, 1888, which has enormously heavy earth-work and an unusual number of bridges on it.

Starting eastward from Christchurch the line crosses the Avon by a 5-span viaduct, of 60 ft. and 40 ft. spans. From this bridge eastward for 2½ miles there is an embankment about 25 ft. high, containing 575,000 cu. yds. For more than a mile each slope is protected by a stone wall at the foot, 5 ft. high. There are 10 small bridges on this part of the line, the gradients varying from "1 in 137," (0.73 per cent.) to nearly level. After this embankment comes a cutting, 2 miles long, with a depth of 20 to 35 ft., the total excavation being 400,000 cu. yds. It is entirely in sand and clay. It was intended to take out this cutting with slopes of 1½ to 1, but the clay proved of such a treacherous nature that the slopes had to be flattened, a part of the cutting now having a slope of 2¾ to 1. Moreover, in many places, chalk counter-forts, 5 ft. wide and 15 ft. apart, had to be built in the slopes.

There are 8 bridges on this part of the line, and the maximum gradient is 0.5 per cent. A short embankment brings us to a cutting, 1½ miles long, with a total excavation of 180,000 cu. yds. For about 2 miles the line consists of relatively small cuttings and embankments, when another embankment is reached half a mile long and estimated at 650,000 cu. yds. It was originally intended to make this embankment 67 ft. wide at the top and 60 ft. deep, with slopes of 1½ to 1, the extra width being to make room for surplus excavations; but it was soon found that the material of the bank would not stand at such a slope. The level of the line was lowered until the embankment was reduced to 50 ft., and the slopes were flattened to 2½ to 1: two level benchings 10 ft. wide being introduced in each slope, and finally counterforts were built as well. These are 15 ft. apart, 10 ft. wide, nearly as thick as they are high, and are carried up to within 6 ft. of the top of the slope, one of them containing as much as 12,000 cu. yds. of chalk. Further on the line crosses the Lyndhurst road by a skew bridge, with most massive iron-work.

Nearly all the bridges are constructed with a separate arch for each line of railway, the lines being spread out to make room for the brick pier between them. This entails the purchase of more land and increases the cost of excavation in the cuttings, and would seem therefore to have been needlessly expensive as compared with double-track arches built in the ordinary way.

As a whole, the line is not a particularly creditable specimen of engineering, it would seem, although the extremely heavy earthworks are largely accounted for by the slippery character of the materials (more than 100,000 cu. yds. of chalk and stone have been used to support the slopes) and the necessity of crossing over or under a great number of highways close together. In all there are 40 such bridges in 10 miles, about equidistant from each other. The original contractors gave it up after a year's work; but their successors completed it successfully. Figures of cost are not given.

The New Westinghouse Automatic Compound Engine.

The simple Westinghouse engine became long since a standard machine, and its many admirable qualities as a cheap, light, convenient, economical and well nigh indestructible motor are well understood. The new engine which we illustrate, which is not yet on the market, and which accordingly may not have the precise form in all details of our illustrations, is an attempt to retain all the advantages of the simple engine with the additional economy gained by compounding and the addition of a condenser.

It will at once be seen that the regular Westinghouse engine offers special advantages for compounding, because it has two cylinders and pistons to begin with, the steam acting only on the down stroke of each so that there is no lost motion to be guarded against. In the new compound, one of these cylinders becomes the high pressure and the other the low-pressure cylinder, and the valves, instead of being between the two cylinders are placed on top of them, still preserving, however, the perfect balancing which is so important a feature of the simple engine.

The comparative economy which is indicated by the tests so far made is very great. Whereas the simple engine, under favorable conditions, uses from 36 lbs. of steam (4 lbs. coal) per H. P. in the smaller engines to 29 to 30 lbs. steam (3¼ lbs. coal) in the larger engines, steam pressure being taken at 80 lbs., the tests so far made of the new engine show the following striking results, running down in the condensing engines, at 120 lbs. pressure, to but little more than 2 lbs. coal per H. P. in all the condensing engines, even the smaller sizes, which not so very long ago was up to the best marine practice, although now 1⅛ and 1⅛ lbs. per H. P. is realized in the high grade marine engines.

Tests of the Westinghouse Compound Engine 14 ins. and 24 ins. × 14 ins.

(Tested February, 1888. Built at Pittsburg, Pa.)

WATER RATES PER BRAKE HORSE-POWER AT VARYING PRESSURES AND LOADS.

CONDENSING.

Brake Horse-Power.	Boiler Pressure.			
	120	100	80	60
200	19·62	21·53		
160	18·86	20·02	23·17	
130	18·38	19·56	21·32	24·3
100	19·14	19·44	20·34	23·1
70	19·8	20·05	21·43	22·57
40	22·9	23·12	24·75	25·25

NON-CONDENSING

Brake Horse-Power.	Boiler Pressure.			
	120	100	80	60
200	23·94			
160	23·5	25·2		
130	24·32	26·24	27·7	
100	25·57	27·75	29·8	
90	26·51	28·3	29·8	31·7
70	29·4	30·77	32·48	36·0
40	40·05	39·3	42·75	45·82

Unjacketed and uncorrected by calorimeter.
Nominal H. P. of Condensing Engine..... 180 H. P.
" " " Non-Condensing Engine..... 150 " "

By comparing the drawings we present with those of the simple engine, which most of our readers interested in the subject have at hand or can readily obtain, it will be seen that this result is accomplished, at least so far as the non-condensing engine is concerned, by no additional weight or complication of parts, since the 14 and 24 × 14 engine nominally rated at 150 H. P. and running up to 200 H. P. even with only 100 lbs. pressure with excellent economy, corresponds to the 15½ × 14 in. single engine, also with two cylinders. In a brief circular lately sent out to members of the American Society of Mechanical Engineers, (in advance of any printed matter on the subject) the Westinghouse Machine Co. thus comment on the new engine:

The results thus far obtained are almost as surprising to ourselves as to others who are conversant with the facts. The tests are still in progress, principally to obtain statistics at a higher range of steam-pressures than has heretofore been available in our own works.

In our ordinary automatic engines (of which some 3,000 are now in use) the principal points that seem to have won public favor may be briefly stated, as follows: 1st. The complete avoidance of the effects of lost motion on all reciprocating parts, by the self compensation of the single-acting principle. 2d. A high enough

initial speed to admit of the engine transmitting its *entire power*, through direct connection, to the work to be done, rather than to waste a large percentage of it and the fuel consumed) in propelling devices whose

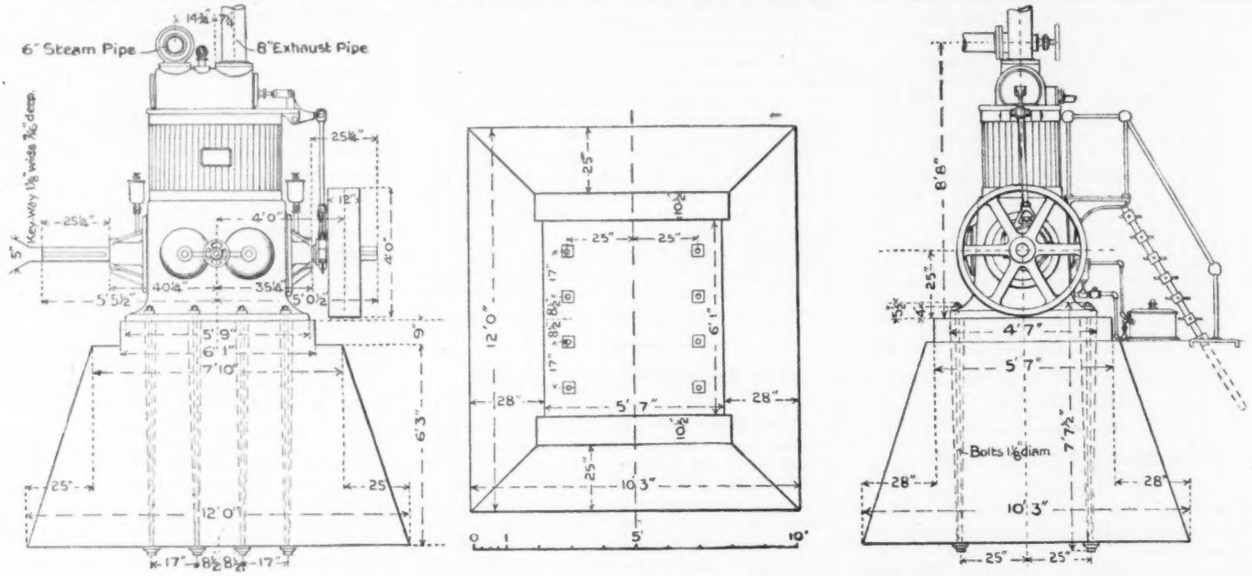


Fig. 1. Plan and Elevations of the New Westinghouse Automatic Compound Engine.

sole object is the production of requisite speeds. 3d. A complete automatic lubrication of every part, so as to provide against the frailties and weaknesses of human nature. 4th. An automatic governor, so lubricated constantly that the standard rate of speed is maintained on

Engines, and to add the following points, which we consider desirable:

1st. To obtain the recognized economies in fuel, to be had through compounding, without any complication or excessive cost, so that these engines can be placed on the market, in the strictly commercial sense, from the smallest size to the largest. 2d. Practically no more complication or mechanism than exists in the simplest engine. 3d. A greater economy of fuel than

upon the market. They are only intended to show the general principles of design, and to give some idea of the results obtained.

The new compound engines have almost identical piston speeds and revolutions per minute with the single engines of the same nominal horse-power. The only detail which seems a retrogression is in placing the eccentric and valve-stem outside the case, where they must be separately lubricated and

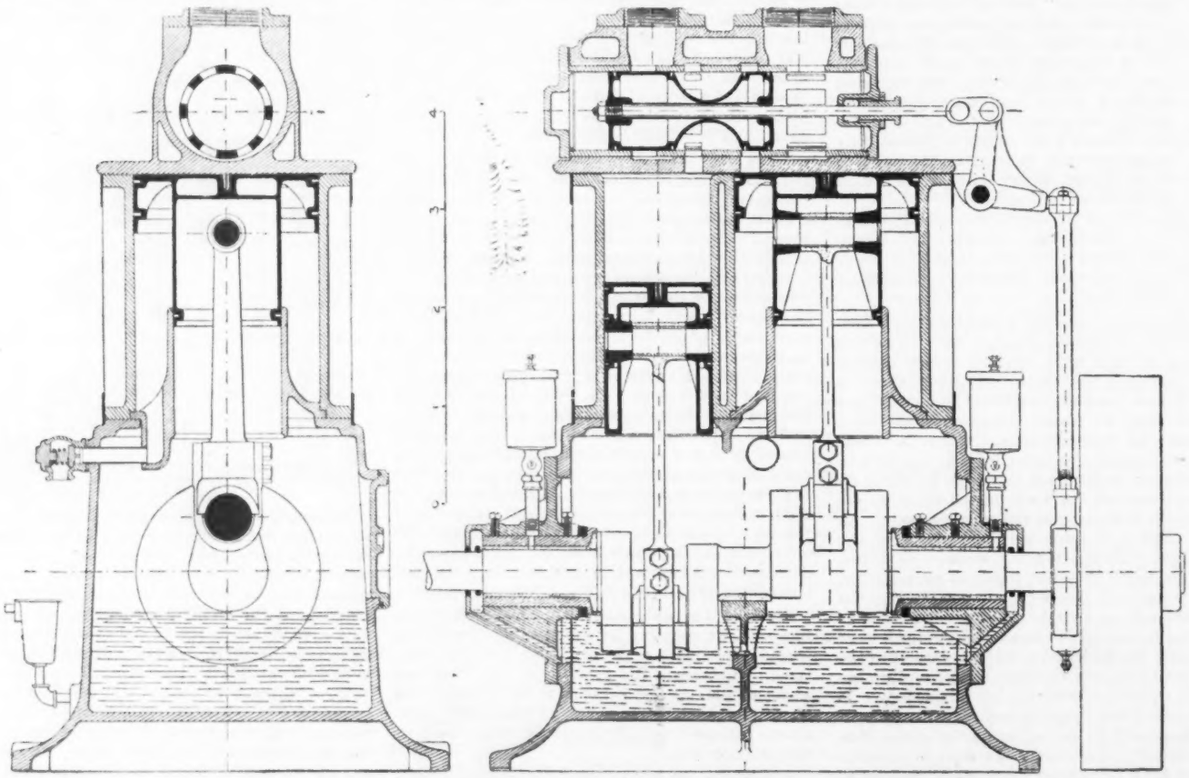


Fig. 2. Sectional Views of the New Westinghouse Automatic Compound Engine.

each and every stroke of the engine, instead of maintaining an average rate of speed. 5th. Through our high speeds (forbidden in double-acting engines) less weight per horse-power; less loss through internal condensation; less space occupied, and less cost to the buyer.

Some other points of superiority in our Automatic Engines have been commended, from time to time, but need not be referred to specially.

In designing the new engines, our aim has been to cover all the features now so popular in our Automatic

retofore obtained by anyone in engines of equal horse-powers. 4th. A complete and perfect control of the steam supply to both high and low pressure cylinders, through the medium of a single balanced valve. 5th. The ability to maintain an absolutely constant speed, under varying steam pressures and loads. 6th. The best results throughout, combined with the greatest simplicity and the least cost.

The drawings sent have been made from time to time, as the tests progressed, and do not represent the finished engine in the condition in which it will be placed

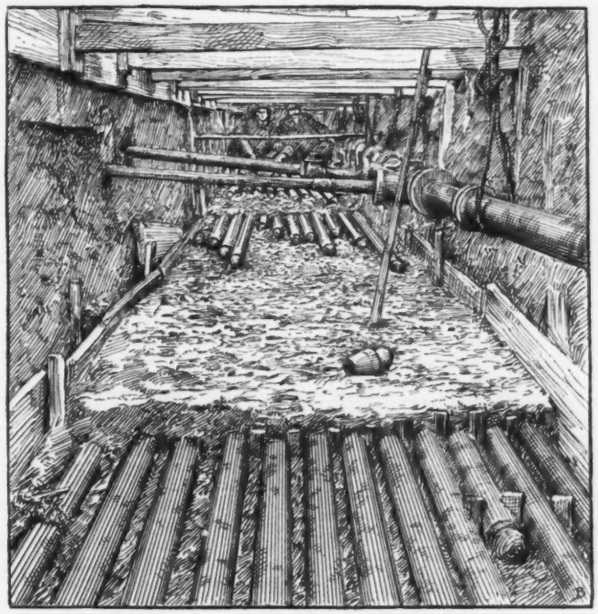
cared for, but this, though probably unavoidable, has certain advantages, while it is at the most a small price to pay for the additional economy. It is proposed to run the compound engines up to 500 H. P. (25 and 42 by 20-ins. stroke, the same engines rating as condensing at 600 H. P. The list of the simple type stops at 250 H. P., 20 × 16-ins. cylinders. Altogether, this new engine cannot but excite general interest, and we shall hope to give fuller details later.

Electrical Subways of New York.

(Continued from page 309.)

CONDUCTORS.

The best form of conductors to be used in the underground ducts has not yet been determined. The method of construction necessitates some form of cable which will contain all the wires to be placed in one duct, as it would be impossible to introduce or remove a single wire of a cluster while in the duct. Many forms of cables embracing the use of various kinds of insulation have been suggested, and new forms are being constantly presented, and several varieties have been used. The tendency, however, seems to be towards one in which a number of copper wires insulated with cotton fibre are formed into a cable and drawn into a lead pipe, into which paraffine is injected under pressure. The lead in the pipe usually has a small proportion of tin added to it, thus enabling it to resist the action of the gases, which cannot be kept out of the conduits. In making the cables for the telephone service the wires (No. 18, Am. gauge) are insulated with the cotton fibre to a diameter of $\frac{1}{16}$-in., and twisted in pairs to form a metallic circuit; and 50 pairs (100 wires) are placed in layers to form the cable. A slightly spiral direction is necessarily given to each layer, but in *opposite* directions for adjacent layers. In the case of the telegraph cables single wires, instead of pairs, are used, as a metallic circuit is not required; their size and number depends on the service they have to perform. For arc lighting and power cables the conductors, instead of being of single large wires, are made up of a number of smaller wires for each conductor. The thickness of the lead casing is about $\frac{1}{16}$-in.



Electrical Subways in New York. Manner of Laying in Cement a Line of Sheet-Iron Pipe.

The cables are drawn into the ducts in the following manner: A "needle" with a rope attached is first bent through the tube from manhole to manhole. This needle consists of light rods of wood or metal, in lengths convenient for handling in the manhole, joined together with screw joints and introduced section by section. If the two successive lengths of duct are in the same line the needle can be sent on through the next length without disjointing it; otherwise, and in a great many cases, it has to be taken apart in withdrawing it, and introduced into the next length in sections as before. When the needle and front of the rope has been sent through a length of the duct the other end of the rope is attached to the cable, and the latter is pulled through by means of a windlass. The ends of the sections of cable are united in the manhole and covered with insulating material and lead.

In the Edison Electric Illuminating Co's. system the underground conductors are laid on both sides of the street, at the bottom of the trenches that are excavated to a depth of about 2 ft. below the surface, their center lines being about 30 ins. from the curb-line. On top of the conductors is placed a heavy creosoted plank, 4 to 6 ins. wide, to protect the tubing from accidental injury from picks or crowbars during excavation for other purposes. The tubing is constructed as follows:

The conductors, three in each tube, are of solid copper wire or rods, of size depending upon the service, in some cases running up to $\frac{5}{8}$ in. diameter, and are thoroughly insulated, and enclosed in heavy wrought-iron tubes of from 1 to 3-in. diameter in sections about 20 ft. long. The sections are made complete at the shops, the work of construction in the trench being confined to joining the completed sections together. The joints between successive sections are thus 20 ft. apart, or some multiple of 20 ft., according to circumstances, and are enclosed in cast-iron boxes fastened to the tubes. In a line so constructed the continuous cable of jointed sections is completely surrounded by a tough, adhesive elastic, water-proof insulating compound. The system of laying it makes it possible to tap it at any point. The electrical connections are made by means of flexible copper cables, and are enclosed in cast-iron boxes to which the tubes are joined by means of a special form of ball and socket joint. At the street corners manholes are placed, extending to a depth of 3 ft., and with covers level with the street surface.

Two sets of conductors are laid: the *mains*, which deliver the supply of electricity to the consumers, and with which the connections are made; and the *feeders* which lead direct from the station to specified points on the mains and conduct all the current to the latter. The connections between the mains and the feeders are made at the manholes.

At another point a single entrance into a block in connection with house-top distribution, has proved efficient.

CONNECTIONS.

The Subway Company is allowed by the Board of Control to furnish whatever the several companies may desire in the way of connections between the manholes and points desired to be reached. In some cases the company has employed the hand-hole system of distribution for the use of the telephone wires in down town streets.

M. DE LESSEPS has again displayed his distinguished talents as a political manipulator by overcoming the late pronounced majority against him in the *Corps Legislatif*, which he has done by bringing about pressure from their honored constituents. How much this is going to help him remains to be seen, but it will certainly assist him somewhat.

CORRESPONDENCE.

A correspondent asks:

"Will you kindly inform me who deals in fine aneroid barometers. The catalogues of our instrument makers seem to contain only inferior instruments, not bearing the name of any reputable manufacturer."

These things change so frequently, that we are unable to say who is now the best maker of fine aneroids. Perhaps some of our readers can give the information.

The Origin of a Weir Formula.

KANSAS CITY, MO., April 25, 1888.

EDITOR ENGINEERING NEWS:

Can you give me the source of the following form of Francis' Weir formula, as adapted to cases where h is less than 0.5 ft. and l is over 3 ft., viz:

$$Q = 3.43\,(l - 0.34)\,h^{\frac{3}{2}}$$

I think it appeared in print some four or five years ago.

The coefficients given by FANNING (*Hydraulic and Water Supply Engineering*, p. 289) covering depths from 1 to 6 ins., vary from 3.263 to 3.329, which would give results considerably lower than the formula in question.

Very truly yours,

KENNETH ALLEN.

[We leave it to some engineer who makes a point of keeping posted on such details to answer this query.—ED. ENG. NEWS.]

The Laying Out of Irrigating Canals.

127 *East 23d St.* NEW YORK, April 20, 1888.

EDITOR ENGINEERING NEWS:

Many notices have appeared in your journal within the last two years to the effect that a company would build an irrigating canal so many miles long, and so many feet wide. Not having seen more than one bottom width referred to in any of these notices, it looks as if some of these canals were being built at variance with the first cardinal principles of economical construction, as applied to works of this kind.

The construction of an irrigating canal, as understood in Europe, is associated with the idea of a diminishing capacity of discharge, and a nearly uniform depth of water. The execution of the work under these conditions, calls for a decreasing base or bottom width, to the end that the water surface of the canal may be maintained at a nearly uniform height over the natural surface of the ground throughout the line of the canal.

There could not well be a more deliberate, or senseless waste of money than that involved in the building of an irrigating canal with a constant bottom width, and there are only two possible but highly improbable cases known to the writer where such a method of construction as applied to works of magnitude could be defended; viz., (1), The case of the upper section of an unfinished canal to be reduced in width further down, or (2), The case of a combined canal of navigation and irrigation, a combination not likely to be made.

The following will give a general idea of preliminary methods as applied to the surveys of irrigating canals, adopted by the late I. P. ROBERTS of the Public Works Department of India, and imparted by him to the writer by actual practice many years ago

First, find out by rapid leveling with two rods and guess distances the average fall of the river from which the water is to be taken for about half the length of canal below the point selected for a dam; then, cross the valley at right angles to the general course of river to find the lateral slope of the valley, and make a rough guess at the area that may be made subject to irrigation. These levels should have one or more bench marks left about the finishing point.

A grade is then adopted to suit the ground and give about the right velocity for a trial prism of the upper stretch of canal based on the area assumed and the quantity of water to be furnished turned into cubic metres (or ft.) per second.

The leveler commences work with reference to the assumed level of top of dam over datum and drops down grade, guessing his distance in the first instance, and setting so many plugs at about grade

level as far apart as uniformity of surface and the best kind of leveling will admit of. The transit line is kept behind the leveler and runs a general average through the course of these plugs which are numbered from 1 forward, and offsetted by the hind chainman as he passes them by and enters it in his book.

Suppose the level of the top of dam to be 100 metres above datum, and it is desired to keep the water surface generally 0.5 metres over that of ground: The leveler commences to drop grades not from 100 metres but from 99.5 metres. As a consequence at least 0.5 metres of embankment will be found necessary to retain the water within the prism of canal, and the top of embankments may be made as much higher than the water level as the engineer desires.

As the leveler goes ahead and guesses his distance he has two rods and takes a cross-section at each plug to take up the error of his guess work, when he gets so far ahead as to have lost confidence in his guess work, he waits until the chain comes up, gets his correct distance and grade thereby, compares the number of the last plug with the hind chainman and goes ahead again. If the line be found to rise higher than thought necessary, or if it is desired to drop down out of bluff ground, he (the leveler) may drop so many metres vertically out of his grade for a mill fall, and go ahead again dropping his grade as before.

When the plan is plotted and the grade points and all other levels recorded upon it, the engineer lays down his curved center line, gets his plan distance therefrom, and compiles a profile upon grades modified to suit the plan distance.

When this profile is made, the general surface will conform to the modified grade, and the water line, (being marked, with the assumed height of 100 metres—or as may be—above datum at the up stream end) will stand generally 0.5 metres over the natural surface, the top of embankments being drawn in as much higher as the engineer decides.

This done the main lateral distributing channels are located on the plan according to judgment, at about right angles with the general course of the canal, and the areas of the tract of land above the first main lateral, as also those situate between each pair of main lateral distributing channels lower down, are taken out and recorded on the plan.

Having got these areas, the depth of one and number of irrigations per period of time per unit of area, the engineer turns this into cubic metres per second, for the first up stream area, deducts it from the total discharge of canal for the whole area of the valley, and proceeds to calculate the prism of his canal below the first lateral channel, modifying its section so as to get about the right velocity, the diminished discharge, and the same depth of water as nearly as possible. At the second main lateral channel he repeats the calculation and so on, down to the end of canal.

The result of this method of progression diminution might necessitate the end sections of canal being made equal to zero in area, supposing the water to be consumed with the regularity covered by the calculated areas of discharge. As, however, this is never the case in practice, some section toward the end of the canal (according to its length) is made continuous from the place of its adoption up to the terminal point.

It is proper to say here that when the preliminary survey is made to the terminal point of canal it is necessary to turn back, cross the valley and traverse its lower irrigable boundary, (generally the river) up to the site of the dam, in order to be able to calculate the correct area of the whole valley. This traverse then forms a closed polygon.

In order to reduce the probability of errors of chainage, or rather to correct them, if any very prominent point can be seen about the center of the valley it is well to intersect that object very frequently, to the end that if the length of any particular line be found not to check by its bearing from one end only, that particular line may be located as a place of error.

The foregoing will give a general idea of an economical, quick and sufficiently correct method of surveying an irrigating canal for preliminary purposes.

If any irrigating engineer finds it as useful to him as it once was to the writer the perusal will repay the trouble of reading and leave something to spare.

Yours truly, H. P. BELL.

Steam Consumption of Simple and Compound Non-Condensing Engines.

At a meeting of the Institution of Civil Engineers, March 13, Mr. P. W. WILLIAMS, M. Inst. C. E., read a paper on "Economy Trials of a Non-Condensing Steam Engine—Simple, Compound and Triple", republished in *Engineering*, from which we abstract the following details of general interest, especially in connection with the details of the new Westinghouse compound condensing and non-condensing engine, which we illustrate in this issue. The sizes of the cylinders are not specified, but as will be seen from the following table the engine was a small one.

The author described a series of economic trials, non-condensing, made with one of his central-valve triple-expansion engines, with three cylinders in line and but one crank. By removing one or both of the upper pistons, he obtained at pleasure a compound or a simple engine. Distinct groups of trials were made by the author under conditions very favorable to a satisfactory comparison of results, no jackets being used. Check-trials were made by Mr. MACFARLANE GRAY, Prof. KENNEDY, Prof. UNWIN, and others.

Intended mean pressure lb.	40	90		110		130	150		160		170
Simple, compound, or triple.	S.	S.	C.	S.	C.	C.	C.	T.	C.	T.	T.
Actual mean admission pressure.	40·88	92·65	87·54	106·3	109·3	130·6	149·9	151·9	158·5	158·1	172·2
Percentage ratio of actual mean pressure, referred to L.P. piston, to theoretical mean pressure.	98·2	100	91·3	100·7	94·8	94·2	94·6	84·54	95·9	85·3	85·2
Indicated H. P.	16·51	31·61	29·14	33·5	33·0	36·31	38·59	35·69	39·15	35·56	38·45
Feed water actually used per indicated H. P. hour.											
Simple lb.	42·76	26·89	.....	26·0							
Compound lb.	.....	.....	24·16	.....	21·37	20·35	19·45	.....	19·19		
Triple lb.	.....	.....	.....	.....	.....	.....	.....	19·68	.....	19·19	18·45
Steam required theoretically per indicated H. P. hour lb.	34·67	19·24	19·86	17·9	17·65	16·25	15·23	15·16	14·87	14·9	14·36
Percentage efficiency.	81·1	71·5	82·2	68·8	82·5	80·0	78·3	77·0	77·4	77·6	77·8

The weight of steam theoretically required per indicated horse power per hour was determined by Mr. MACFARLANE GRAY'S formula. The trials were all made with the engine running at 400 revolutions per minute, and a part of the results are embodied in the accompanying table.

Owing to greater loss in passages, a compound engine must always give a smaller diagram than a simple engine, and a triple a still smaller diagram than a compound, considered with reference to steam present at cut-off. Nevertheless, in this trial, even with absolute pressure 80 lbs., the compound engine gave the best results, showing decreased initial condensation, smaller loss from clearance and less leakage than the simple engine. These gains became more apparent with increasing wear. No injurious effects seemed to result from the greater surface in the compound engine. The trials completely confirmed the view that the compound engine owes its superiority to reduced range of temperature, together with the fact that they can and do use higher initial pressures. At the unavoidably low pressures of the triple trials the losses, due to another set of passages, almost neutralized the saving in initial condensation; but with considerably higher pressures it seems probable that there would be greater economy in triple expansion.

ENGINEERING NEWS.

THE hydraulic forging press of the Atlas works at Sheffield, is said to be the most powerful tool ever made. It exerts a nominal pressure of 4,000 tons, but its actual maximum pressure is considerably greater. Three furnaces of 100 tons separate capacity, heat the metal, and two 150-ton traveling cranes convey and manipulate the forgings.

AT a recent meeting of the Royal Society, Edinburgh, a preliminary note on the duration of impact by Prof. TAIT, was communicated. When a wooden block weighing 10 lb. fell through a height of 18¼ in. on a rounded lump of gutta-percha, the time of impact was 0.001 sec., and the co-efficient of restitution was 0.26. There is a wide field for some very useful further experiments in this direction, as to which definite experimental knowledge is still scanty, although there are plenty of theories.

THE Ohio Valley and Central States Centennial Exhibition will open in Cincinnati July 4, and continue 100 days. Eleven States are officially connected with its management. It is said that the buildings will occupy nine squares in the center of the city, giving an entire floor space of 23 acres, and requiring for their construction 3,000,000 ft. of lumber and 30 car loads of glass. The main building is to be 600×400 ft.; Park Building 600×110 ft. with a 136-ft. tower; and Power Hall 1247×112 ft., with the Miami & Erie Canal running through it.

THE New York Central Railroad Co. have completed arrangements for equipping all their principal stations between New York and Buffalo with new patent enamel station signs, furnished by The American Patent Enamel Co. Each station will be provided with one large sign from 12 to 16 ft. long on which will appear in white 9-in. letters, on a blue ground, the name of the station, with the mileage to New York at one side and the mileage to Buffalo on the other.

Two other signs exhibiting the name of the station will be erected on posts, one on each side of the station, at a distance from it of about 100 ft.

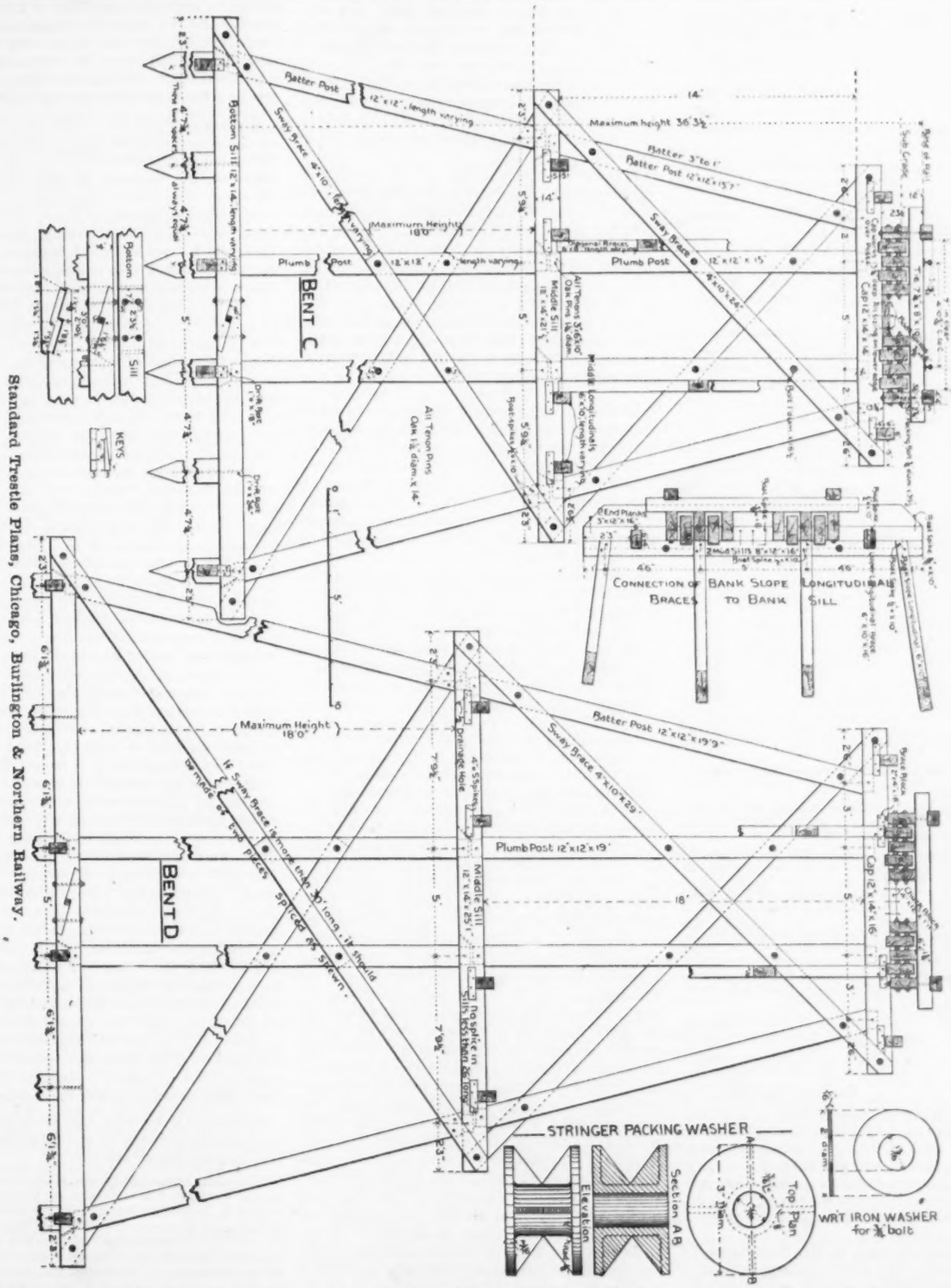
The signs are said to be almost indestructible and are of much handsomer appearance than any painted signs.

THE great contract let about three weeks since to a London company represented by Boes-Scott, Reed, Campbell & Co. for the drainage of the city of Mexico is for a tunnel 6 miles (9,520 metres) long, about 13×13 ft., lined throughout. The material is all the peculiar Mexican material called tepe-ta-te, for which there is no English equivalent, because the material itself is unknown in English-speaking countries. It resembles most closely very soft-burned non-porous brick, and is admirable material for tunnel-driving, holding its form for months or years without lining, with no danger of falls, and very readily excavated. The contract price was $2,400,000 silver, which amounts to about $57 per lin. ft. gold. The city has been at work for over a year on preliminary installations, brick kilns, etc., and has expended $250,000 for them.

THE enormous excavation from the city of Mexico to this tunnel, about 48 kilos. (29 miles) long, and increasing from 5 metres to 20 metres deep at the mouth of the tunnel, with slopes of 1 to 1 is yet to be let, and will, we hope, fall into American hands. A loan of £3,700,000 was taken by Berlin, London and Amsterdam bankers at 70 and placed on March 23 at 78½; two weeks later it was selling at 2 per cent. premium. We shall give further and more complete details of this great work later, with illustrations.

THE following are the lengths of some of the principal railways of South America: Buenos Ayres Great Southern, 832 miles; Buenos Ayres Northern, 20 miles; Buenos Ayres & Ensenada, 35 miles; Buenos Ayres & Rosario, 341 miles; Central Argentine, 246½ miles; East Argentine, 99 miles; Northern Colonies of Santa Fé, 260 miles; Central Uruguay, 190 miles; North West of Uruguay, 112 miles; Alagoas, 55 miles; Donna Christina, 73 miles; Great Western of Brazil, 86 miles; Imperial Brazilian, 75 miles; La Guaira & Caracas, 23 miles; Lima, 17½ miles; Minas & Rio, 106; Recife & San Francisco, 77½ miles; San Paulo, 86½ miles; South Brazilian, 175 miles.

A COMPANY has been formed for the purpose of constructing a tramway in Honolulu, the capital of the Hawaiian kingdom. The length of the proposed line, which will pass through the business and residence parts of the city, is about 12 miles.



Standard Trestle Plans, Chicago, Burlington & Northern Railway.

We continue our illustrations of these trestles which were described in our issue of April 7, in an article by A. F. ROBINSON, Bridge Engineer of the road. We have still to present some further drawings of pile trestles, pending which, we will not attempt further description.

A REPORT from Birmingham, Ala., states that a new process of dephosphorizing iron for steel making has been invented by N. A. PRATT, State Geologist of Georgia, and is to be put in operation there. The cost is given at 20 cts. per ton.

AN architect writing to the *Insurance World*, referring to the fact that many fires can be traced to defective brick work, and that it is a great error to plaster flues on the inside, or to slush walls having flues in them, says that the vertical joints should be filled with mortar from bottom to top, and that this can be accomplished by keeping the flue lining a few inches in advance of the brick work, and shoving the bricks adjoining the lining up against each other in soft mortar. It is asserted that ordinary slushing leaves an opening the entire length of the wall; and when the plastering falls off from the inside, the flue is left open to the vertical joints in the brick work, across which the joists pass.

THE failure of a break chain on a Jersey City street car resulted in the injury of 3 persons.

IMMIGRATION is again falling off, the decrease in Irish immigrants being most noticeable. The figures given for corresponding periods in 1887 and 1888 comprise about 98 per cent. of the immigration into the entire country, only that from Canada and Mexico being omitted:

	1888	1887	
Month ending March 31	31,928	39,676	Decrease 2,748
3 months ending March 31,	69,623	64,295	Increase 5,328
9 months ending March 31,	293,230	260,961	Increase 32,269

Baltimore and Philadelphia received only two-thirds as many immigrants in March, 1888, as in the same time in the preceding year.

THE Mexican government has granted a concession to LUIS HULLER for a railroad in the States of Chihuahua and Sonora.

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D. McN. STAUFFER. A. M. WELLINGTON.

EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

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Coming Technical Meetings.

Engineers' Club of Philadelphia, Pa.—Regular meeting, May 5. Secy., Howard Murphy 1122 Girard St.

Engineers' Club of Kansas City, Mo.—Regular meeting, May 7. Secy., Kenneth Allen, 19 Deardorff Building.

Civil Engineers' Society of St. Paul, Minn.—Regular meeting, May 7. Secy., Geo. L. Wilson, City Hall.

American Society of Mechanical Engineers.—Next meeting at Nashville, Tenn., May 8 to 11. Secy., F. R. Hutton, 280 Broadway, New York City.

New England Railroad Club.—Regular monthly meeting, May 9. "Heating Passenger Cars by Steam." Secy., FRANCIS M. CURTIS, Boston & Albany R. R. Passenger Depot, Boston, Mass.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, May 15. Secy., S. M. Wickersham, Penn Building.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, May 16. "Small Pipe Sewers." Secy., S. E. Tinkham, City Hall.

American Society of Civil Engineers, New York.—Regular meeting, May 16. "High Masonry Dams," Jas. B. Francis. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Regular meeting, May 16. "Water Way between the Lakes and the Mississippi," R. E. McMath. Secy., W. H. Bryan, 709 Market St.

Missouri [illegible] of Surveyors and Civil Engineers.—Annual Meeting at Columbia, Mo., beginning May 31. Secy., T. J. Lowry, Columbia.

Master Car Builders' Association.—Next convention at Alexandria Bay, N. Y; commencing June 12. Secy., M. N. Forney, 45 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy. Angus Sinclair, Chicago.

WE have received from MR. THOS. C. CLARKE, Trustee of the New York & Brooklyn bridge, the following letter:

DEAR SIR: In an editorial article upon p. 340, of ENGINEERING NEWS for April 28 some of the Trustees of the Brooklyn Bridge are accused of inserting false items in an estimate. It further goes on to speak of these as "falsifications of fact."

Taken in connection with the context, I can only understand this as referring to the action of the Terminal Committee—President JAS. HOWELL and myself.

While I admit the right of Mr. WELLINGTON to criticise fully all that I have done, and to differ in opinion from me in all respects, he has no right to use his position as editor of ENGINEERING NEWS to charge me with "falsification of fact".

I hope that this was written hastily, and without due consideration of its meaning, and if so, that a retraction will be made in the next number of ENGINEERING NEWS, with a proper regret that such a statement should have been made.

I am, very respectfully,

T. C. CLARKE.

Nothing which appears in these columns, of an important nature, is written hastily. Our charge was, and is, "that false items aggregating nearly $4,000,000, for which there was absolutely no foundation or necessity, *were inserted* in a comparative estimate which was sprung upon a non-technical body at a moment's notice, with a request, which was acceded to, for immediate action"; in other words, that the false items *were there.* We not only do not charge, but we do not know, that any particular person is responsible for the falsity of the estimate, but simply that it is in fact false, as respects about two-thirds of its aggregate.

This being so, the easiest and the only way of obtaining such a retraction from this paper as MR. CLARKE requests is to show that the impeached estimate is defensible, in some one item at least, either in these columns, or before the Board of Experts, to which Mr. WELLINGTON has demanded that all the late action be referred. We earnestly hope that Mr. CLARKE feels the same anxiety that Mr. WELLINGTON does to have the exact facts in the case established, for he is in a position to ensure such action being had.

IT will be seen from an interview reprinted on our news page that MR. CLARKE now asserts that he was not only "in favor of the circulating system before the Board met', which the written record shows, but that he "still believes it is the proper system", and "would have voted for it but for the enormous sum which Superintendent MARTIN said it would cost." How this declaration, if authentic, as we have reason to believe it is, is reconciled with the report of the Terminal Committee, as published in our issue of April 21, we do not know, and we certainly cannot undertake to weigh the part of individuals in this matter. The most we can say is that there is something exceedingly crooked and wrong about it somewhere.

THE bill now pending in Albany authorizing a bridge over the Hudson river at New York with spans of 1,300 ft., plainly intended to be for a cantilever structure, and putting the practical control of the project, and even the issuing of the charter in the hands of three men, Messrs. LIBBEY, Ex-Gov. HOADLEY and Gen. GEO. S. FIELD, of the Union Bridge Co., seems to deal with this important matter in a most unduly sweeping and hasty way. It is claimed that only one pier will be required in the river, but this seems practically impossible, without much longer spans than specified, and although it is extremely desirable that a bridge of some kind should be built at the earliest possible moment, and we should be loath to throw a straw in its way, yet it should at least be clearly shown that it is necessary to put piers in the river before they are permitted. The question stands on a very different basis from what it would over an ordinary river or at other points of the same river, and there is also the further objection that the cantilever type will not offer sufficient rigidity to permit the running of fast trains or to ensure durability, while it is certainly very doubtful if the introduction of river piers would result in any economy as compared with a single suspension span clearing the whole channel with one leap, and offering a more worthy and rigid structure as well as a more economical one, on a basis of equal convenience, if the claims made in regard to it be well founded, and they have certainly not yet been impeached. The paper of Mr. GUSTAV LINDENTHAL, which we published in the early part of this year, offered a plan entirely suitable and unobjectionable in its details which was claimed likewise to be cheaper than if the span were cut in two by a central pier, on account of cost of foundations.

The bill is loosely and improperly drawn in many ways. For one thing it does not specify how many tracks the bridge is to carry. No structure carrying less than six tracks, with possibilities of further enlargement, should be permitted, for the reason that a second structure should never be necessary, and the additional cost of fitting the bridge for more tracks is but a trifling percentage of the total.

WE have commented from time to time in our Railroad News columns on the progress of the great Leavenworth & Denver Air Line Railroad, not because we have at any time supposed it to have any more prospect of ever reaching maturity than the numerous other vast enterprises which bloom so profusely on Kansas soil; but because, when the daily press and our contemporaries in the railroad field devote so much space to this and to similar enterprises, we think it for the interest of our readers to keep them informed of such progress as is made in the way of surveying and obtaining funds, pointing out at the same time how exceedingly small is the prospect of the success of its sanguine promoters.

A brief history of this Leavenworth & Denver Short Line is about as follows: The citizens of the city of Leavenworth have long mourned over the fact that their city is not as big and does not "boom" as fast as Kansas City, although until about 25 years ago Leavenworth was the larger of the two, and in the pioneer days was much the more important. It is the custom nowadays when a city does not build up as rapidly as its real estate agents desire, to ascribe the stagnation to the lack of railroad facilities and to the narrow policy of managers of existing lines. Leavenworth is not located on one of the east and west trunk lines, and in the hope and belief that corner lots might some day sell at fabulous prices, certain of the citizens of Leavenworth organized last August a company to build a railway straight to Denver, about 430 miles. After much exertion and many fervent appeals to the patriotism and public spirit of the citizens of Leavenworth, money enough was raised for a preliminary survey of the portion of the line in the State of Kansas. "Several offers were considered from accomplished engineers" according to report, and the contract for making the survey was finally let to JOHN MCCARTY. Recently the promoters of the project endeavored to interest the Denverites in the work and succeeded in having DONALD FLETCHER and others, of Denver, incorporate the Colorado & California Short Line to continue the Leavenworth line to the Pacific Coast; and the absurd story was telegraphed all over the country that the Chicago, Milwaukee & St. Paul was behind the whole scheme and proposed to build a direct line from Leavenworth to San Francisco.

THE latest news from the promoters of this magnificent scheme is the following note in the Denver *Republican*:

"President DONALD FLETCHER, of the Colorado & California Railroad, has returned to General Manager ALLER in Topeka the approval of the Directors of the ordering of the survey from the Colorado-Kansas line to Denver. The work will begin on May 1, under the direction of JOHN MCCARTY, Civil Engineer. Mr. MCCARTY will employ a large corps and push the work as rapidly as is consistent with the running of a substantial and permanent survey. The contract is let at $15 a mile, so that the surveyors will be instigated to work industriously for the purpose of getting their pay. The Colorado & Pacific is assured and will be the most direct line, in connection with the Leavenworth, & Denver Short Line, to the Missouri river."

"Instigated to work industriously" is very good. But there is this much to be said for the policy of letting surveys to the lowest bidder in this case. There is no earthly prospect that the survey will actually be made use of in the construction of a railroad; and as it thus makes little difference whether the surveyors' work be good, bad or indifferent, it is for the manifest advantage of the promoters

to sink as little money as possible in the work. This being the case the surveyors can have a rollicking good time tramping over the country in the pleasant May weather, and as they locate their line up hill and down dale and around sharp corners, they need never be troubled by qualms of conscience over the probable results of hauling traffic over it in the uncertain future.

A CORRESPONDENT writes us:

"Referring to your article headed "The American Inventors of the Telegraph" I wish to ask if it is true that STURGEON, an Englishman, in 1825 discovered the Electro magnet. I have always thought it an uncontradicted fact that Prof. H. C. OERSTED, a Dane, made that discovery—I think in 1824—and if I am wrong I know of a good many others who are. Could you not help us to give justice to the right man also in this case?"

We are unable to answer this question without an amount of investigation, which we cannot now undertake. The *American Encyclopedia* says:

"In 1819 OERSTED discovered the power which the current possesses of deflecting a magnetized needle out of the magnetic meridian. In 1820 SCHWEIGGER added the multiplier. This was followed by ARAGO's discovery in the same year that a steel rod was magnetized when placed across a wire that was carrying a current. AMPERE immediately substituted a helix for a straight wire. In 1825 STURGEON used soft iron in place of steel, and the electro-magnet was born. Between 1828 and 1830, Prof. HENRY, of Princeton, N. J., made great improvements in the construction of electro-magnets by covering the wire and winding the coil compactly. In 1831, he devised an instrument which is essentially the same as the Morse register."

We do not undertake to say that what we have given decisively answers our correspondent's questions, but it is as far as we can go without considerably more investigation.

IN the obituary of the late CHAS. LATIMER, in ENGINEERING NEWS of April 7, we expressed a doubt whether the "International Institute for Preserving and Perfecting the Anglo-Saxon Weights and Measures", which Mr. Latimer founded and sustained, largely by the force of his own personal magnetism, would be kept alive long after his death. The April number of *The International Standard*, the organ of the Society, seems to confirm this belief, for in the notice of Mr. LATIMER's death the Publishing Committee say: "The next number of the *Standard* may be indefinitely postponed". The title page of the journal has long carried this note: "This magazine is published on the responsibility of CHAS. LATIMER, therefore, neither the members individually, nor the Society need assume any responsibility". It is to be hoped, however, that respect for the memory of Mr. LATIMER will induce the other members of the Society to continue the publication of the journal devoted to the cause in which he so devoutly believed, for a short time at least. We have small sympathy with the beliefs of the Society, but this much is due to Mr. LATIMER's memory.

THE notice of the approaching Nashville meeting of the American Society of Mechanical Engineers comes to us with a complete set of proofs, bound separately in pamphlet form, of the following tremendous list of papers to be read at the meeting:

	PAGES.
"Duty Trials of Pumping Engines," by J. S. COON,	8
"Surface Condensers", by J. M. WHITMAN,	11
"Large and Enlarged Photographs and Blue Prints", by R. H. THURSTON,	4
"Automatic Regulator for Heating Apparatus", by J. T. HAWKINS,	5
"A New Method of Inserting and Securing Crank Pins", by C. C. COLLINS,	2
"Estimating the Cost of Foundry Work", by GEO. L. FOWLER,	6
"A Safety Car Heating System", by HENRY R. TOWNE,	10
"Connecting Rods", by W. F. MAITLE,	6
"Notes on Warming Railroad Cars by Steam", by WM. J. BALDWIN,	5
"A Foundry Cupola Experience", by F. A. SCHAFFLER,	4
"The Best Form of Nozzles and Diverging Tubes", by A. F. NAGLE,	6
"A Plea for the Printing Press in Mechanical Engineering Schools", by JOHN T. HAWKINS,	6
"Steam Excavators," by WILLIAM L. CLEMENTS.	19
"Strains in Locomotive Boilers", by L. S. RANDOLPH,	5
"An Electric Speed Recorder", "The Effect of Circulation in Steam Boilers on the Quality of the Steam", "Memoranda of the Performance of a Compound Engine," by GEO. H. BARRUS,	9
"A Short Way to Keep Time and Cost", by HENRY L. BINSSE,	7
"Proportioning Steam Cylinders", by R. H. THURSTON,	7
"A Persistent Form of Gear Tooth", by J. BURKITT WEBB	5
"Wire Rope Fastenings", by WILLIAM HEWETT,	6
"The Mechanical Significance of Viscosity Determinations of Lubricants", by JAMES E. DENTON,	7
"The Distribution of Steam in the Strong Locomotive", by F. W. DEAN,	21
"The Displacements and the Area Curves of Fish", by HARRY DE B. PARSONS,	17
"River Practice of the West", by J. M. SWEENEY,	11
Total, 27 papers,	186

Each paper is preceded by the usual notice to each member, that it is sent out that discussions may be prepared in advance, and to "BRING THIS COPY WITH YOU TO THE MEETING." The contrast both in the number, and in the condition of the papers with those which are usually presented at the Conventions of the much larger and richer American Society of Civil Engineers is a notable one. It is to be remembered in fairness, that the latter Society holds semi-monthly technical meetings at which papers are read throughout the year, their Annual Convention being in addition thereto, while the Mechanical Engineers hold no other meetings than two or three Conventions a year. Still, many of the most important civil engineering papers are presented at the Convention, and yet, instead of having 27 practically complete papers issued to every member in advance, only a few of the "civil" papers are in type, these only in "galley proofs" and rarely distributed before the meeting, while not infrequently some of the papers prove to be not even in manuscript, in complete form.

The Galesburg Water Bond Case.

Perhaps there is no one cause which has contributed more of late toward the general introduction of a water supply into every city and every village of size in this country, than the fact that money for the construction of these works could be easily obtained at a low rate of interest. The reasons why the bonds representing the capital expended in constructing the permanent plant of a waterworks company should be regarded as a thoroughly safe investment are easily understood. A large share of the money is invested in the mains where it is absolutely safe from accident, and danger of serious loss to the plant as a whole by disasters of any sort is a very small one. Again the percentage of the original cost required to keep the works in repair is smaller than in almost any other enterprise in which capital is invested; and even with mismanagement and carelessness, serious loss is hardly possible. The income from the sale of water to consumers and to the city is in every way stable and sure, and in almost all American cities has been and is rapidly swelling from the increase in population and the increase in the consumption of water per capita.

This low rate of interest is certainly no detriment to investors, for because of the absolute safety they are well satisfied with small returns. In fact, with the rapid increase in wealth which is going on all the time, there are never enough of these "gilt edged" investments to supply the demand; and any enterprise which is sure of steady returns for a long term of years is always nowadays able to find capital for its work at from 3 to 4 per cent., whereas railroad companies which, except for the great uncertainties as to their future management, ought to command nearly equal public confidence, have to pay even when the present management is good nearly 1 per cent. more as a penalty for the possible loss which future mismanagement may bring.

While the investing public have thus been benefited by this low rate on water-works securities, it needs no proof that the communities where water has been introduced, and everyone connected with the trade in water-works supplies of all kinds, has been helped in far greater proportion.

It is quite certain that the demand for new water supplies and for the improvement and extension of established works will continue and increase with the rapid growth of our city population; but as with every other commodity, the consumption will vary as the price, and any increase in the rate of interest on water-works securities will be found at once to put a damper on the projects for new works and for the extensions of existing ones. Evidently, then, the engineers, contractors and manufacturers who are interested in the construction of water works are vitally interested in anything tending to hurt the good reputation which water-works securities have hitherto held.

It is undeniable that much mischief of this sort has already been done and the unfortunate fact is that, as the investing public as a general rule buys with little discrimination, the failures of a few poorly managed enterprises, started only to boom some mushroom town, works great harm to the sellers of sound and safe securities. A like injury is effected when our final arbiters, the courts, fail to protect the bondholders' vested interests; and if the recent opinion of Judge GRESHAM in the case of the City of Galesburg, Ill., *vs.* The Galesburg Water Company is to be followed as a precedent, we fear there will result a very perceptible injury to the market for water-works bonds.

The facts of this case, briefly stated, are these. In 1883 the City of Galesburg, Ill., granted a 30-year franchise to NATHAN SHELTON for the construction of a system of water-works to supply the city with pure water of a specified abundance. The old mains which the city had used to furnish such a water supply as had existed previous to that time were sold to SHELTON, and formed part of the distribution of the plant erected by the Galesburg Water Co., to whom SHELTON assigned the franchise. On Dec. 6, 1883, the Water Company tested the works in the presence of the Common Council and to their satisfaction, and by an ordinance passed on the evening of the same day, the works were declared to meet the requirements of the contract.

Not many months later complaints became current concerning the character and quality of the water, and in the fall of 1884, the company admitted that its contract requirements had not been met, and agreed to sink gang wells to increase the supply. After the wells were sunk, however, the request for a second test was denied by the company, and it was proved in court that its supply was not then equal to the contract requirements. The water furnished was impure and insufficient in quantity, being drawn from a creek and swamp polluted by the drainage from slaughter houses, and by night soil and dead animals dumped into it by scavengers. On June 1, 1885, the City Council passed an ordinance rescinding the contract with SHELTON, and repossessed itself of its old mains for protection from fire. It also brought suit to set aside the contract, alleging fraud and non-compliance on the part of the water company. Meanwhile the company had defaulted in the payment of the interest on its bonds and the Farmers' Loan & Trust Co., the trustee of the mortgage, was made defendant in the suit. It was offered on

behalf of the bondholders to take possession of the works, and improve them so that they should meet the terms of the original contract, but for some reason this was refused.

The salient feature of the case seems to be the fact that the works were formally accepted by the city authorities and that it was by exhibiting this documentary evidence of its property that the company was enabled to market its bonds. The decision of Judge GRESHAM, however, was as follows:

"A reference will be made to the Master to ascertain and report the fair value of the water furnished to the city by the Water Company; and when the city shall pay into court for the Bondholders' Committee the amount thus ascertained, a decree will be entered annulling the contract and establishing the city's title to the old mains."

Although unacquainted with the details of the case, we venture to assume that the public sentiment in the city failed to distinguish between the original projectors of the enterprise and the innocent purchasers of the bonds, and that it was probably hostile to any further dealings of any sort with the company. Perhaps it was this public enmity towards the company which influenced Judge GRESHAM'S decision. But even then we fail to discern the justice or wisdom which permits the city, on payment of a nominal sum for a few months hydrant rental, to oblige those who invested in good faith in securities guaranteed by the city authorities, to forfeit the capital they have invested in the improvement of a city, and refuse them all opportunity of carrying out the contract in good faith. If this precedent were to be followed, we see no reason why a large number of municipalities who have been the victims of pretty sharp bargains in dealing with water-works franchise seekers might not be successful in annulling their original contract, to the financial detriment of the bondholders and in a much greater degree to water-works interests in general.

But it is not alone as an infringement of the vested rights of bondholders, and as a warning to investors to exert some degree of care in buying securities, that this case is of interest. Many would argue from it that it was another case of the folly of entrusting to private enterprise the responsible task of furnishing a city with water. But in the present state of our municipal governments it must be seriously questioned whether the public at large in the smaller cities of the country is not much better served by the existing water-works companies than it would be if "the water question" was an element in city politics, and the water department was run by aldermanic wisdom. Where the city of Galesburg made a mistake seems to have been in giving a franchise without sufficient precautions to ensure the reliability of the contractor. The trade seems to have been made in a sort of haphazard fashion and with no especial care to see if the city was getting as good a bargain as could be had, and if the bargain once made would be faithfully carried out. The practice of selling franchises by means of sealed proposals is slowly coming into vogue and is to be heartily commended. If the city of Galesburg had asked for bids on the basis of well drawn specifications and had brought this request to the attention of the reliable builders of water-works in the proper way, it is altogether probable that its five or six years of delay, litigation, inconvenience, and real danger would have been avoided. Certain it is that no reliable firm, nor engineer worthy of the name, would ever have permitted the impounding of swamp water and slaughter house drainage for domestic use.

One other point, as to which we have not full information, is the character of the so called test which influenced the City Fathers to accept the works as fully up to the standard of the contract. Here, too, we should judge the services of an intelligent engineer were sadly needed, but were not secured. The report lays stress on the fact that the works were tested in the presence of the Common Council. It was doubtless very easy to make a showy exhibition to astonish and delight the impressible souls of the well primed aldermen, and they would not be slow to vote that it was "the finest water supply in the country;" but a systematic engineering test to determine the real excellence of the work is quite another thing, and such a test, as we understand, was not then made. Perhaps they thought it would cost too much, for there are few things which afford so tempting an opportunity to the economically disposed mind as to save the salary or fee of an engineer.

The trite saying in reference to the expensive tuition of experience is no less true for its triteness. It is to be hoped that the several expensive terms which the city of Galesburg has taken may be enough for it and many other of its sister cities as well.

The Plans of the Lackawanna Managers.

It is not without reason that the securities of the Delaware Lackawanna & Western are all held at prices far above par. The men who are at the head of the company's affairs act as if they believed that a railway property is to be managed on the same principles that govern other legitimate business enterprises, and that it is better to earn money by honest and conservative management than to capture it by manipulating the stock market. Within a few months a project has been carefully matured which there is every reason to believe will be carried out at an early day and will result in great advantage to the Lackawanna properties. The main line of the company extends from New York to Buffalo through the anthracite regions of Pennsylvania and the road has always been considered principally as a "coaler", though its passenger traffic is by no means a small one. The principal holders of the company's stock also own most of the securities of the Green Bay, Winona & St. Paul road, extending from Green Bay, Wis., west to the Mississippi river near Winona, Minn., 210 miles. As announced in our issue of April 14, Messrs. SLOAN, BLAIR, HALSTEAD and others prominent in the Lackawanna Company have taken up the Winona & Southwestern project, which is a proposed line from Winona, Minn., southwest to Omaha, Neb., about 300 miles, of which 72 miles from Fort Dodge to Mason City, Ia., were built in 1886. The company already owns a fleet of steam propellors and has recently made several additions to it, doubtless with a view of the bulky freight which it may carry by its new route from the Iowa and Nebraska prairies to the seaboard. By the construction of the Winona-Omaha line the company can secure a heavy grain traffic from Nebraska, Iowa and Minnesota, and it can direct a heavy traffic westward over its lines from its position in the anthracite coal trade. It is undeniable that this move affects the supremacy of Chicago as a collecting and distributing center for the whole Northwest; but that city is well able to fight its own battles, and it must certainly inure to the benefit of the Western farmer if he is enabled to get his grain to the seaboard at a lower cost. As far as the interests of the railroad company are concerned there is no doubt that the enterprise it has set on foot can be made to yield large returns for the comparatively small outlay of capital required. The most discouraging feature of the enterprise is the socialistic attitude which the State of Iowa has lately assumed toward railways. But the laws passed at the session of the legislature just closed are not as unjust as was feared, and it is to be hoped that wiser and more conservative men will be at the head of the State government in the future.

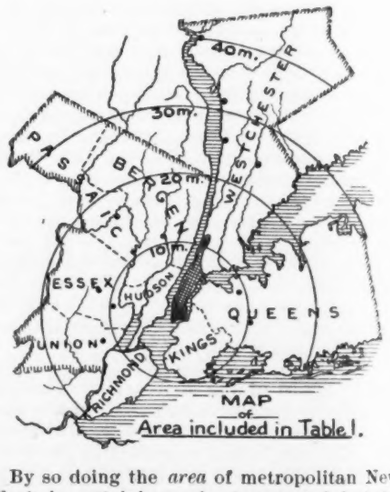
The Past and Future of New York.

II.

THE PAST OF NEW YORK.

We reviewed last week, in opening an investigation of what the future growth of New York is likely to be, the figures as to the growth of the total and the city population of the United States as a whole, with the resulting conclusion that the TOTAL city population of the United States is likely to about double between 1880 and 1900 and to again double between 1900 and 1920, so that in or about the latter year it is likely to be four times what it was in 1880. These facts were shown in Tables IV. to VIII. which we do not repeat. The growth of New York City as a whole has heretofore been in a far more rapid ratio than that of the country as a whole, or than that of any of the Eastern cities. We proceed now to summarize where and when this growth occurred, and the causes therefor so far as they can be perceived, before proceeding to estimate the future probabilities.

In determining what area should be included as part of metropolitan New York for compiling Tables I., II., and III., we have, partly for convenience and partly because it is really more just and leads to safer conclusions, included entire counties as shown in the accompanying maps, viz. five counties in New Jersey, including Newark, Jersey City, Hoboken, Elizabeth, Orange, etc.; the whole of Westchester Co., which extends up the river as far as Peekskill; the whole of Kings and Queens Co., on Long Island, which includes besides Brooklyn, Long Island City and some strictly suburban minor towns, a considerable area which is still mere farming country, and the whole of Staten Island.



By so doing the *area* of metropolitan New York is certainly much exaggerated, but the population only slightly so, and this only by a nearly constant addition of 50,000 to 100,000 of farming and market-gardening population, the plain effect of which is to diminish the apparent rapidity of growth, since such rural population grows but slowly. Thus, if we go back a century, to 1790, it is beyond question that, of the total population of 111,864 (Table I.) on the area now included as metropolitan New York, not more than the 33,131 at most, on Manhattan Island, was in any sense city population, and not all of that. More than

50,000 out of the total was purely rural population, which has grown but slowly.

But of the decennial increases of population since that date, shown in Table II., all but a small fraction have been city population proper, including suburban residents whose business interests are in the city, and the percentages of growth shown in Table III. are very decidedly less than they should be if this small fraction of rural population were not included, especially in the earlier decades. To have separated the rural from the metropolitan population, would have been an almost impossible task, requiring the inclusion of a different area for each census, and would have introduced more danger of error than it saved. Practically, therefore, we may say that Tables I. II. and III. exhibit in a conservative way all that the past has to show for the growth of metropolitan population.

For the three decades preceding 1820, the growth of New York was extremely slow, rather less than the rate of the State at large. Manhattan Island gained 92,000 on 33,000, and the whole metropolitan area 160,000 on 112,000, but this was chiefly rural growth, was at a decreasing rate and apparently was in a measure due to omissions in the 1790 census. Even steam ferries were not yet; Brooklyn and Jersey City were not even foreshadowed, and the growth of New York and all its surrounding areas was visibly coming to an end for lack of further chance to grow. In 1810-20 Brooklyn began to foreshadow its future importance by growing faster than New York, but largely because of its insignificant population to start with. Manhattan Island contained almost exactly half of the total population included.

In the decade ending in 1830 a great change began. Fulton's first steam-boat began to act as a common carrier in 1808, and the first steam ferries at New York were established in 1812-13, but it was not till after 1820 that these inventions began to have great practical effect. The Erie Canal was begun in 1817, and opened in 1825; the locomotive became an established fact in 1830, and the railway was even then clearly foretold and accepted as a leading factor in the future development of the country. The first street cars in the world ran from Prince St. to Harlem in 1832 (the cars being in the form of three stage-bodies on a single set of wheels with side doors only, and with a bench in front for the driver). All these causes combined to lead to a sudden and marked increase in the rate of metropolitan development, so that the modern era may be said to date from the decade, 1820-30. Table II. shows this at a glance, and in Table III. we have averaged the decennial rate of growth for the entire period of six decades, 1820-1880, by which the fluctuations of the succeeding decades can be compared.

In this decade (1820-30) the *city* of Brooklyn first began to exist, as also Newark, New York proper increased two-thirds in population. The remaining area included as metropolitan showed very slight growth, the average of the whole area being 44.8 per cent.

In the decade 1830-40, the New York Central was nearly built from Albany to Buffalo and the Erie well started. Part of the New York, New Haven & Hartford was also opened, and the Harlem was well under way. The Lake Shore was also built in part and the West developing rapidly, and with it the traffic of the Erie Canal. Great but less rapid growth (54 per cent.) continued on Manhattan Island; Westchester Co., and Staten Island for the first time began to feel the stimulus of metropolitan growth, and Brooklyn grew enormously (132 per cent.).

TABLE I.

POPULATION OF THE VARIOUS COUNTIES AND SECTIONS MAKING UP THE METROPOLIS OF NEW YORK, IN EACH DECENNIAL CENSUS, 1790 TO 1880 INCLUSIVE.

	1880	1870	1860	1850	1840	1830	1820	1810	1800	1790
Hudson Co., N. J.	187,944	129,067	62,717	21,822	9,483	—	—	—	—	—
Bergen Co., "	36,786	30,122	21,618	14,684	13,223	22,414	18,178	16,603	15,156	12,601
Passaic Co., "	68,860	46,416	29,013	22,538	16,734	—	—	—	—	—
Union Co., "	55,571	41,859	27,780	—	—	—	—	—	—	—
Essex Co., "	189,929	143,839	98,877	73,944	44,621	41,928	30,793	25,984	22,269	17,785
Total, New Jersey	539,090	391,303	240,005	132,988	84,061	64,342	48,971	42,587	37,425	30,386
New York Co.	1,164,673	942,292	813,669	515,547	312,710	203,007	123,706	96,373	60,489	33,131
Westchester Co.	150,614	131,348	99,497	58,263	48,686	36,456	32,638	30,272	27,428	24,093
Total, N. Y.	1,315,287	1,073,640	913,166	573,810	361,396	239,463	156,344	126,645	87,917	57,134
Kings Co.	599,495	419,921	279,122	138,882	47,613	20,537	11,187	8,303	5,740	4,495
Queens Co.	90,574	73,803	57,391	36,833	30,324	22,276	21,519	19,336	16,891	16,014
Total, Long Island	690,069	493,724	336,513	175,715	77,937	42,813	32,706	27,639	22,631	20,509
Richmond Co.	38,991	33,029	25,494	15,061	10,965	7,084	6,185	5,347	4,563	3,835
Total Metropolis	2,583,437	1,991,696	1,515,178	897,574	534,359	353,702	244,206	202,218	152,536	111,864
P. C. Increase, as below,	28.5	27.8	62.7	66.8	48.4	44.8	20.8	31.9	87.3	
" N. Y. State,	15.9	12.9	25.2	27.5	26.5	39.8	43.0	62.8	73.1	
" New Jersey,	24.8	34.8	37.2	31.1	16.3	15.61	2.9	16.2	14.6	
" London,	17.2	16.4	18.7	26.2	23.5	23.51	9.2	19.2	—	

Remarks:—In order to make the comparison a strictly fair one the population of the entire counti s given is included throughout. This includes some considerable areas which are even now chiefly farming regions, but no considerable population. The situation of the counties is shown on the small scale map. There are certain small discrepancies in the figures for population for the various censuses. These are compiled from the volume for each census.

The various counties areas follows:

Hudson Co. Chiefly Jersey City and Hoboken.

Bergen Co. All small suburban townships, the largest being Englewood and Lodi.

Passaic Co. Chiefly Paterson (51,031) and Passaic (6,532).

Union Co. Chiefly Elizabeth (28,229), Plainfield and Rahway.

Essex Co. Chiefly Newark (136,508), Orange (13,207).

New York Co. Manhattan Island only. The population of the annexed wards (23 and 24, 41,626 in 1880) has been subtracted from N. Y. Co. and added to Westchester Co. in 1880, in order to preserve equality of comparison.

Westchester Co. Extends 43 miles up the river, but the population is nearly all suburban. Yonkers (18,892) and Peekskill (6,893), chief towns outside of annexed wards.

Richmond Co. Consists entirely of Staten Island. Population chiefly at north end.

Kings Co. Chiefly Brooklyn (566,663) with the country towns of Flatbush, Flatlands, Gravesend, New Lots, New Utrecht.

Queens Co. Chiefly Long Island City (17,129) Flushing (15,905) Hempstead (18,164). The county extends out some distance on Long Island, but the population is mostly at the extreme west end.

TABLE II.

INCREASE OF POPULATION IN DECENNIAL PERIODS FOR VARIOUS SECTIONS OF THE METROPOLIS OF NEW YORK 1790 TO 1880.

	1870 to 1880	1860 to 1870	1850 to 1860	1840 to 1850	1830 to 1840	1820 to 1830	1810 to 1820	1800 to 1810	1790 to 1800
Hudson Co.	58,877	66,350	40,895	12,339	—	—	—	—	—
Essex Co.	46,090	44,962	24,933	29,323	2,693	11,135	4,909	3,715	4,484
Other Co's	42,820	39,986	41,189	7,265	17,026	4,236	1,575	1,447	2,550
Total N. J.	147,787	151,298	107,017	48,927	19,719	15,371	6,384	5,162	7,039
Manhattan Island	222,381	128,623	298,122	202,837	109,703	79,301	27,333	35,884	27,358
Westchester Co.	19,266	31,851	41,234	10,577	12,230	3,818	1,366	2,844	3,425
Total N. Y. proper	241,647	160,474	339,356	213,414	121,933	81,819	23,699	38,728	30,783
Kings Co.	179,574	140,799	140,240	91,269	27,076	9,350	2,884	2,563	1,245
Queens Co.	16,771	16,412	20,558	6,509	8,048	757	2,183	2,445	877
Total Long Island.	196,345	157,211	160,798	97,778	35,124	10,107	5,067	5,008	2,122
Staten Island	5,962	7,537	10,431	4,096	3,881	899	838	784	728
Total Metropolis	591,741	476,520	617,602	364,215	180,657	109,496	40,988	49,682	70,672

TABLE III.

PERCENTAGES OF GROWTH OF POPULATION FOR VARIOUS SECTIONS OF THE METROPOLIS OF NEW YORK, IN DECENNIAL PERIODS, 1790 TO 1880.

	1870 to 1880	1860 to 1870	1850 to 1860	1840 to 1850	1830 to 1840	1820 to 1830	Av'ge. 1820 to 1880	1810 to 1820	1800 to 1810	1790 to 1800
Hudson Co.	45.6	105.8	187.4	130.1	—	—	—	—	—	—
Essex Co.	32.0	45.5	33.7	(65.7)	(6.4)	36.2	35.4	18.5	71.4	20.3
Other Co's.										
Total, New Jersey	37.8	63.0	80.5	58.2	30.7	31.4	49.2	15.0	11.4	25.8
Manhattan Island.	23.3	15.8	57.8	64.9	54.0	64.1	45.3	28.4	59.3	82.6
Westchester Co.	14.7	32.0	70.8	19.7	33.6	11.7	29.0	7.8	10.4	14.3
Total, N. Y. proper	22.5	17.6	59.1	58.8	50.9	53.3	42.6	23.4	44.1	53.9
Kings Co.	42.8	50.4	101.0	191.7	131.8	83.6	94.2	34.7	44.7	27.7
Queens Co.	22.7	28.6	55.8	21 5	36.1	3.5	27.1	11.3	14.5	5.5
Total, Long Island	39.9	46.7	91.5	125 5	82.0	30.9	66.2	18.3	22.1	10.4
Staten Island	18.1	29.6	69.3	37.4	54.8	14.5	35.9	15.7	17.2	19.0
Total Metropolis.	29.7	31.4	68.8	68 0	64.1	44.8	48.2	20.8	31.9	36.4
N. Y. State.	15 9	12.9	25.2	27.5	26.5	39.8	24.4	43.0	62.8	73.1
New Jersey.	24.8	34.8	37.2	31.1	16.3	15.6	26.4	12.9	16.2	14.6
London	17.2	16.4	18.7	26.2	23.5	19.2	21.5		small	

The next decade, 1840-50, saw New York's largest growth (64.9 per cent.); Brooklyn multiplied nearly three-fold, the Jersey towns still grew slowly but faster than ever before (58 per cent.); Westchester Co. and Staten Island fell off. All this time there was only one street car line in New York or Brooklyn, the Third Ave.; and at the end of the decade there were only 3,740 miles of railway in all the middle States, Maryland, Ohio, Indiana and Michigan included. The population of 515,000 in New York proper and 139,000 in Brooklyn was therefore about all that could well exist without new means of internal transportation.

The next decade, 1850-60, began the street car era, the second line in New York, the Sixth Ave., having been opened only in 1852, although by 1860 there were six lines carrying 36,000,000 passengers per annum, (45 trips per inhabitant) about one-eighth of what are carried now, and one-fifth as many trips per inhabitant. In the same decade, it is needless to say, the railway system of the country obtained enormous development. These causes still maintained a very rapid rate of growth which in the Jersey towns, remoter Long Island and Westchester Co., was far greater than ever before (suburban railway travel then first beginning), while New York proper grew very fast. As a whole, the enormously rapid growth of these two decades 1840-60 was the plain result of the introduction of the railway as a factor in modern civilization, radically changing the conditions on which it existed. We can trace the same effect in Philadelphia, Boston and London (Table III, V, and VI.), beginning in the latter city a decade earlier than here, because the railway on a large scale was introduced there earlier.

In the next decade, 1860-70, the war came, and it would be natural to ascribe the rapid falling off in growth of all parts of the metropolitan area chiefly to that cause, as it undoubtedly should be ascribed in part, but we have only to compare with London and with the growth of the next decade in New York, Boston and Philadelphia to see that it is very largely due to other causes. The Jersey towns continued to grow very rapidly, increasing about two-thirds in population. Even Westchester Co. had a very respectable increase, although much smaller than before. Brooklyn (Kings Co.) had the same absolute increase as in the preceding decade, when it had a very large one. The great falling off was on Manhattan Island, where the population grew only 130,000 (16 per cent.) against 300,000 (58 per cent.) in the preceding decade.

In the next and closing decade of the U. S. censuses, 1870-80, the metropolis as a whole reached the lowest rate of growth which it has ever known, except in the one decade of 1810-20, when the slow growth was largely due to the war of 1812-15 and its preceding embargo. It is now tolerably clear, likewise, that this is a lower rate of growth than it is likely to know for some decades to come, and that it was very largely due to the inferior methods of internal city transit, which were fast fixing a positive limit to city growth when elevated railways were introduced, in 1878. The first elevated line (Ninth Ave.) was opened in 1872, but it transported an insignificant number of passengers for several years, and it was not till 1879 that the influence of elevated railways began to be at all felt on the growth of the city, and in 1880 the total of their annual passengers was only 60,000,000 against nearly 200,000,000 now. Westchester Co. especially (including under that term the "annexed district" of New York likewise) felt severely the depressing influence of this lack of transportation. Brooklyn and its suburbs continued to grow rapidly, but less rapidly, and under great disadvantages. The Brooklyn resident doing business in New York, as practically all do who support the city, had first to walk to a crowded ferry subject to many interruptions, then take a slow and crowded horse-car, and then finally walk to his home, making a slow and disagreeable trip, so that until the end of the last decade it was only that part of Brooklyn which was within easy reach of the ferries on foot or by a short horse-car trip which had many of the characteristics of a city. Of the Jersey towns this was still more nearly true, except that they had the great advantage of comfortable and rapid steam transit. Staten Island was practically dead, as it still continues to be.

Table IV., which we published last week, and some other data which we shall publish next week, make it a certainty that a very much more rapid growth than in the two preceding decades will be shown by the census of 1890, as a result of the elevated railways and other improved methods of rapid transit, as well as of the general prosperity of the country. London also, vast as it now is, will show the stimulus of these improved transit facilities, whose direct effect was shown in our issue of Oct. 15 last, in a diagram showing the growth of city travel. Moreover, what is a still more important factor of the future, the indefinite multiplication of rapid transit facilities by bridges over both North and East Rivers, by tunnel lines, by "underground" lines near the surface, by elevated lines and even by high viaduct lines, has ceased to be an engineering problem, and become merely a financial one, in regard to which latter, appeal may be made to the experience of the past. It appears highly unlikely that the conditions will ever again become so seriously injurious as they were just before the "elevated" era began, when the radical change involved thereby caused long hesitation. We shall not attempt to present the data indicating the probable growth of the present decade, however, till our next issue.

Summarizing the facts of the past, so far as yet presented, in a little different form: The large Jersey area, which now includes a number of important cities and a total population of 530,000 (1880), only began to fill up with the beginning of railway transportation on a large scale, in 1840, grew very rapidly for three decades, and then fell off materially in rate of growth, which is hardly likely to again become an important factor in metropolitan development until the delay and inconvenience of ferry transit across the North River is eliminated. A North River bridge, with suitable terminal facilities, is likely at any time to greatly stimulate this growth, but hardly to the extent of building up any large surburban cities at so great a distance from New York as they must be to escape the marshes, so long as there is available area for city growth as distinguished from suburban nearer to New York.

Westchester Co. absorbed any considerable fraction of the metropolitan growth only in the two decades 1850-70. Rapid growth has now almost wholly ceased, and if anything may be predicted with certainty it is that it will not be resumed under present conditions, nor until there is true rapid transit by an underground or viaduct line for the entire length of Manhattan Island.

The Brooklyn area has increased in population rapidly and steadily in the immediate vicinity of the ferries, since its growth first began in earnest after 1820, but it has shown little tendency to increase away from the ferries; less on the whole even than Westchester Co. The contrast between Kings and Queens Co. in Tables II. and III. shows this clearly, and indicates that it is the direct effect of inferior rapid transit facilities, a difficulty which is now being in part removed by the rapid multiplication of elevated lines in Brooklyn. The Brooklyn bridge was not opened until 1883, and has had no effect on these statistics.

Staten Island is the most striking illustration in the vicinity of New York of how the greatest natural advantages may be neutralized by inferior transit facilities. It is said indeed that it is malarial, but that is a difficulty easily removed by proper drainage, and small indeed as compared with what has existed at other cities which have multiplied enormously; but excepting in the one decade before the war, Staten Island has from the beginning failed to attract any considerable population, and there seems small reason to expect that it will do so for a long time in the future. The long ferry ride kills it.

It remains to be seen (1) what the past and present conditions indicate is to be the probable future growth of the metropolis as a whole for three or four decades ahead, and (2) how this population is likely to be distributed on what we have termed the metropolitan area. No exactitude can be hoped for in such an estimate, and yet it is possible to determine certain controlling probabilities with more exactitude than might be supposed.

From Paris to Marseilles.

(EDITORIAL CORRESPONDENCE.)

The Paris, Lyons & Mediterranean Railway is the grand trunk railway of France, and with its ramifications commands the entire southeastern section of that country, as far south as Marseilles and east to Bale, Geneva, Nice, etc. As one of the editors of this journal has just been passing over this line a few notes on such engineering and other features as could be snatched from a railway train may be of interest to such of our readers as have not made the trip for themselves. These notes are given with the caution that fast traveling is not conducive to the gathering of careful or valuable statistics; and on the other hand time is lacking between the novel scenes we come abroad to see to permit any very elaborate presentations of what there may be to discuss. Hence these notes must be taken for just what they are—glimpses from a car-window at such features of railroading as are novel to most American Engineers.

Trains on this line are made up in four classes as far as speed and accommodations are concerned. The fastest is the *train de luxe*, corresponding to our limited express, after a Continental fashion, and it makes the 536 miles between Paris and Marseilles in 14 h. 30 m., with 3 5-minute stops, or about 38 miles per hour. It is composed of saloon and sleeping cars alone, and while the regular first-class fare between these points is $21.26, it costs $12.00 additional to travel on this particular train. The next fastest is the *rapide*, composed of first-class cars only and with a buffet-car attached. This train makes the trip in 15 h. 27 m. but makes several lengthy stops. After this comes the *express*, in 18 hours, and the *omnibus* or local train, which latter travels very slowly.

As showing the difference in long journeys, we may quote the fares from Paris to Marseilles. The highest price for a single, ordinary passenger is in the *train de luxe*, which costs $33.26 for 536 miles; the *rapide*, or first-class fare $21.26; the second-class is $15.95, and the third-class is only $10.70, all for the same distance. The chief difference between first and second-class compartments is that one holds 8 and the other 10, and so you may be more crowded, and lastly only first-class passengers can travel by the faster trains. The third-class cars in France present poor accommodations, hard wood seats with straight backs, and the possibility of objectionable traveling companions, both of the two-legged and many-legged types.

If time is not too precious, much the better way is to travel by daylight only, and expend in hotel bills and extra-sight seeing the money that would other-

wise be paid out for a dubious night's rest in a French sleeping car; the first is not only the most comfortable, but also the most economical plan. Following this rule ourselves, we made the trip to Marseilles in two instalments by the *rapide* train, and can give our experience in traveling first-class as follows:

The compartments are comfortable enough, and are handsomely upholstered. But if the one you are in happens to be full it is *not* comfortable for an American traveler to sit all day with knees or feet knocked against a stranger; particularly if your neighbor has an excess of hand baggage, and tries to dispose of some of it on the floor. With the doors and windows shut, there is literally no ventilation, not even an augur hole in the roof; and if your companions are partial to garlic, this arrangement also becomes unpleasant to say the least. At night a gas-light in the roof of the compartment, and separated from it by a tight glass disc, sheds a dim and unsatisfactory light. The locking in of passengers, so often referred to, now only amounts to an outside latch on the door that any passenger can release for himself by reaching out of the window. The latch is simply a precautionary measure, and a very good one, for without it a child, or careless party of mature years, could bring about an ugly accident by fumbling with the ordinary door latch.

The Paris, Lyons & Mediterranean train signal is now electric, and over each door of the compartment is a button which may be pressed to communicate with the *Chef de train*, "only in case of absolute danger." As the small electric cables conveying the signal between cars seemed to be as often uncoupled as coupled after the making up of trains, the authorities of this road either propose to abolish all occasion for danger signals, or they have little faith in their own appliances, and exercise less care over them.

Each compartment is supposed to be warmed by two long, flat, sheet iron covered affairs that apparently conceal hot water pipes, or some soda compound. These foot-warmers were put in at Paris, and renewed at Lyons, and aside from their efficiency in locating each particular corn and bunion, the unhappy traveler might possess, they had little value as heating devices. There was one compensating advantage, however, as compared with the car-stove, and that was there was no danger of fire from them.

While there are no end-doors, and consequently no end-platforms to a French railway coach, there is nevertheless quite an interesting collection of fastenings, etc., between each pair of carriages. First of all there are the four great disc-like buffers with their springs; then two sets of safety chains with weighted hooks to keep theim right side up; the screw-coupling with its long-weighted lever; two somewhat awkwardly fitted air-brake tubes (for Westinghouse is here); two small electric cables for the signal to the *chef* before mentioned, and finally gas-pipes; a device for turning it off and a gas-pressure gauge. As might be imagined, the men making up a train have plenty to do, and they can hardly be blamed for missing an electric coupling now and then.

The buffet-car, as well as the *vagon-lit* or sleeping car, are supposed to be of the "Wagner" type; and while the attendants seem to take great pride in these latest bits of Continental luxury on wheels we did not notice that either class of cars was patronized on our train. As far as the buffet-car was concerned this neglect was explained by a stop of 30 minutes for dinner. And a very good dinner it was too, for 80 cts., "wine included." Our halting place was in the midst of the vineyards of Burgundy, and by the plate of each guest stood two small bottles (half-bottles) of wine with a card to the effect that they could be carried away for use on the train, bottle, sealing-wax, gorgeous label and all, upon the payment of the very reasonable sum of 20 *centimes*, or 4 cts. each. We did not indulge and can not therefore testify as to quality, but very fair wine is cheap in this country and it was probably no worse than some we did drink at hotel tables—which is faint praise, however. Another bit of enterprise was the hiring out of pillows at 1 *f.* each to the traveler who denied himself the dearly bought luxury of a sleeping car; and we can testify to the fact that these high-backed, well padded and well curved seats were not so bad for a perpendicular nap as might be expected. They are far better in that respect than our own cars.

The road-bed of the P., L. & M. Railway is very well ballasted with broken stone or gravel, and with its wooden ties, T-rails and splice-plates looked not unlike one of our own good roads. The rails looked short, hardly 20 ft. long, and this may be accounted for by some difficulty in transportation on the short Continental freight cars. Signalling apparatus was very abundant and apparently of the latest type. The telegraph poles were made of lighter timber than with us, and on curves two poles were braced together in an A-form for greater rigidity. These poles had no cross-pieces, but each insulator was mounted on a separate iron arm spiked to the pole, and, as a consequence, when the wires multiplied some of them were hardly 10 ft. from the ground.

The station buildings were very substantially built, but abounded in bureaus for the multitudinous officials about each, and in the waiting-rooms, etc., for the several classes of travelers. One station appliance, novel to the American eye, was the transfer-carriage, whereby a single car could be injected into the middle of a train or taken out, as the occasion might require. Thanks to the light weight and short length of French cars (which have only 3 pairs of wheels under them) this transfer is not much of an undertaking after all. The machine used is a stout framework of iron supporting on its sides and just over the track rail two low rails to carry the car. At each end of these side rails is an iron skid up which the car to be transferred can be run and blocked in position. Inside the framework are 8 flangeless wheels arranged in sets of 4 and so spaced that they run on a broad cross-track having a central rib coming up between the 2 pairs of wheels at each end of the transfer machine. In other cases small turntables in the parallel tracks and intersecting cross tracks coming from the station sheds permit a very expeditious shifting of cars. Four men are about all that are required to handle a passenger car.

The engines are of the usual Continental type, though both inside and outside cylinders appear to be used; they looked like powerful and business-like machines, excellently finished. The coal in common use is compressed by machinery into blocks, with the chief merit of showing well in the tender and looking well in the yard piles. The water-tanks were usually iron cylinders mounted on masonry or iron pillars, and in several cases we noticed tanks held up by one pillar, which pillar and its continuation through the tank was also a chimney to a brick furnace specially provided to keep the water in this tank from freezing. In all the larger station yards powerful traveling overhead cranes were provided for handling goods.

The freight cars were of several types but the framework of nearly all of them was iron, the box-cars having wooden or plate-iron sides fastened to angle-irons. The standard load for the box-car was 5,000 kilos, or 5 tons, and for the platform cars the load was 10 tons. We saw no freight cars of any kind with more than 4 wheels under them. The French Government requires every railway company to provide and always keep in readiness a certain number of freight cars for military purposes. And this law explains the rather puzzling incription on each box-car of "32 men; 8 horses," which is simply the human and equine capacity of that particular class of car.

The one particular feature of excellence along this line is its most abundant and wonderfully good masonry; in bridges, retaining walls and everywhere where stone can be substituted for wood or iron, stone it is. And this stonework is not only substantial and well cut, but ornate to a degree that would break the heart of any average American railway director. Skew arches abound, with finely cut spiral courses, moulded copings and chamfered quoins; and these are only for country road-crossings and footways. Drainage ditches are often made of regularly laid masonry, and retaining walls extend upward 50 ft, or more in height and at other points the company's right of way was marked for miles by walls of well-laid stone. In one section where the native stone was a rather thin and roughly bedded shale, the courses in this boundary wall were pitched at an angle of 45°, changing the direction of pitch every 100 yards. This masonry possessed the advantage of making its own coping and was much less readily torn down than if the same stone had been laid in horizontal courses. We hope to have more to say on French masonry in connection with house building.

We cannot conclude these remarks on this typical French railway without referring to the great and invariable politeness of even the lowest hireling in the company's employ. The guard requests your ticket with an "if you please", and instead of the curt American "All aboard", we here have literally translated, "To your carriages, if you please, gentlemen". Of course this politeness is a natural characteristic, but it sounds strangely, nevertheless, to an ear trained to the very different method of expressing for similar demands in our country.

PERSONAL.

C. O. WHEELER has been appointed Superintendent of the Northern & Middle divisions of the Wisconsin Central Ry.

N. D. MILLER, Chief Engineer of the St. Paul, Minneapolis & Manitoba Ry. has been appointed Engineer of Maintenance of Way in addition to his other duties.

THE paper read at Cleveland on the "Indirect Income of Water Supplies" was credited to F. S. FULLER of Ware, Mass.; it should be of Boston, Mass.

MERRITT W. YEATER, C. E., late with the Gold King Mining & Milling Co., Telluride Col., has been appointed City Engineer of Sedalia, Mo., succeeding A. C. JOHNSON, who has resigned.

JOHN H. PECK, of Troy, N. Y., has been elected President of the Rensselaer Polytechnic Institute by the Trustees of that institution. He is an alumnus of Hamilton College, Class of 1859.

EDMUND BATES DORSEY, M. Am. Soc. C. E., who has been for the last three months examining the Louisville & Nashville and Erie Railway system for English and German stockholders and bondholders, sailed on Saturday on the Umbria, for England, to make his reports. He speaks in strong terms of the notable improvement in the track, plant and structures of each of these systems, a large portion of each being in first-class condition for any traffic. He expects to return some time in July.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—The regular meeting was held May 2, Vice-President J. J. R. CROES in the chair. No paper was presented, but some discussions on previous subjects were read by the Secretary. It was announced that JAMES B. FRANCIS, Past President, will read a paper on "High Masonry Dams at the next meeting, May 16.

The following candidates were declared elected:

MEMBERS.

KENNETH ALLEN, Kansas City, Mo.
LATHAM ANDERSON, Cincinnati, O.
THOMAS ASPINWALL, Boston, Mass.
ROBERT BASSEL, Technical Attaché, Imperial German Legation, Washington, D. C.
HARRY DEAN BUSH, Supt. Lachine Works, Dominion Bridge Co., Montreal.
CLARENCE ALLEN CARPENTER, Div. Eng., Chicago, Milwaukee & St. Paul Ry., Chillicothe, Mo.
GEORGE EDWIN EVANS, Engineer of Water-Works, Helena, Mont.
FRANCIS DAVIS FISHER, Res. Eng., Suburban Rapid Transit Co., New York City.
ARTHUR HODGES, Chief Engineer, Johnson Steel Street Rail Co., Johnstown, Pa.
GEORGE WASHINGTON HOWELL, Morristown, N. J.
EVERETT WILSON LEWIS, Asst. Eng., Spokane & Palouse Ry., Belmont, Wash. Ty.
EMILE LOW, Div. Eng., Clinch Valley Div., Norfolk & Western R. R., Cedar Bluff, Va.
HARRY IRVING MILLER, Eng. Maintenance of Way, Chicago, St. Louis & Pittsburg R. R., Richmond, Ind.
ARTHUR LORENZO MILLS, Chief Engineer, Toledo, St. Louis & Kansas City R. R., Toledo, O.
EDMUND TROWBRIDGE DANA MYERS, General Supt., Richmond, Fredericksburg & Potomac, Richmond, Va.
PHILIP M. PRICE, U. S. A., in charge of water supply at West Point, N. Y.
BEVERLEY STROTHER RANDOLPH, Mining Supt., Consolidation Coal Co. Frostburg, Md.
THOMAS PEARMAN SHANKS, Chief Engineer, Little Falls Water Power Co., of Minnesota; Louisville, Ky.
GEORGE MORRIS TOMPSON, Chief Eng., Boston & Lowell R. R., Boston, Mass.
THOMAS DELANO WHISTLER, New York City.

ASSOCIATE.

JAMES BRECKINRIDGE SPEED, Gen. Man., Louisville Cement Co., Louisville, Ky.

JUNIORS.

JAMES HILLHOUSE FUERTES, Wichita Land Co., Wichita, Kan.

WILLIAM GRAY, New Croton Aqueduct, Tarrytown, N.Y.

HORACE JOSEPH HOWE, Asst. Roadmaster of Susquehanna Div., New York, Lake Erie & Western R. R., Elmira, N.Y.

EDMUND TROWBRIDE DANA MYERS, Jr., Asst. City Engineer, Richmond, Va.

JOHN EDWIN OSTRANDER, Erie Canal, Macedon, N. Y.

CHARLES BRADLEY ROWLAND, Continental Iron Works, Greenpoint, N. Y.

EUGENE RAYMOND SMITH, Islip, N. Y.

WILLIAM HOLLAND STAIB, Supt. of Construction, Fort Riley, Kan.

GEORGE ATWATER TIBBALS, Continental Iron Works, Greenpoint, N. Y.

SAMUEL GAYLORD TIBBALS, Continental Iron Works, Greenpoint, N. Y.

HERBERT WALDO YORK, New York City.

Missouri Association of Surveyors and Civil Engineers.—The eighth annual meeting will be held at Columbia, Mo., in the engineering rooms of the Missouri State University, beginning May 31. The following papers will be read: "Road Laws of Missouri", C. D. RODGERS; "Stray Thoughts of an Engineer on Railroad Location", M. G. QUINN; "Public Water Supplies from Rivers", W. R. COATS; "Survey of Mines", J. A. SWETNAM; "Building Stones and Woods of Missouri", G. C. BROADHEAD; "Stadia vs. Chain", A. MAITLAND; "Suggestions to Beginners in Land Surveying", T. H. HALLEY; "Photography Applied to Surveying", T. J. LOWRY; "Title by Adverse Possession", H. B. BABB; "Gravel vs. Macadam on Turnpike", J. T. GARRETT; "Open Ditches and Tile Drains", S. J. CARTER; "Duplication of Drawings", W. H. SCHUERMAN; "Strains in Highway Bridges", R. H. BRITT; "Agricultural Experiment Stations", PAUL SCHWEITZER; "Cable Railways", J. M. TAYLOR; "Protection from Incompetency", H. CHOMEAU; "Bridge Details", R. H. PHILLIPS; "Transit & Stadia vs. Plane Table", B. BUSCHER; "The Testing Machine at the Missouri State University", TINIUS OLSEN; "Road Making Materials of Missouri", W. W. CLENDENIN.

The State University now has in successful operation a machine for testing the strength of bridge and other building materials, and it is hoped all attending this meeting will bring specimens of materials to be tested in presence of the association. The sizes of the specimens should be: of stone, 4-in. cubes (smooth hammer-dressed); of wood, 1½ × 1½ × 40 ins., of steel and iron, 1 to 3 sq. in. cross-section, by 18 to 20 ins. long.

Those expecting to attend this meeting should notify T. J. LOWRY or W. E. WRIGHT. All surveyors, ex-surveyors, civil engineers, bridge-builders and instrument makers are cordially invited to attend.

T. J. LOWRY, *Secretary.* G. W. LATIMER, *President.*

American Society of Mechanical Engineers.—The detailed programme for the sessions and excursions, Nashville meeting, May 8th and 12th, is as follows: Hotel headquarters; Nicholson House; rates $2.50. Sessions for Papers (except Wednesday morning), Watkins Institute.

Tuesday, May 8. 10 A. M.: Opening Session. 2 P. M.: Excursion to West Nashville, stopping *en route* at manufacturing points. 5 P. M.: Visit to Fisk University. 8 P. M.: Public Addresses: Gov. TAYLOR, for State of Tennessee; Mayor MCCARVER, for city of Nashville; Gen. G. P. THURSTON, Chairman General Committee.

Wednesday, May 9. 9.30 A. M.: Session for Papers at Vanderbilt University. 11.30 A.M.: Laying of the corner stone of the new University building for Mechanical Engineering; lunch given by the University immediately following. 1.30 P.M.: Visit to West Side Park. 2 P. M.: Excursion to Belle Meade. 8 P. M.: Session for Papers.

Thursday, May 10. 10 A. M.: Session for Papers at Watkins Institute. 2 P. M.: Excursion on Overland Dummy R. R. for Glendale Park, stopping *en route* at new city reservoir. 8 P. M.: Closing Session.

Friday, May 11. 7 A. M.: Excursion *via* N. C. & St. L. R. R. to South Pittsburg and Sequachee Valley, reaching Chattanooga about 7 P.M.

Saturday, May 12. Excursion from Chattanooga to Lookout Mountain and Mission Ridge. Return in the evening.

A list of the papers to be read at the meeting, 27 in all, appears on the editorial page.

Liverpool Engineering Society.—The usual fortnightly meeting of this Society was held at the Royal Institution, Colquitt Street, April 11, 1888: Mr. CHARLES H. DARBISHIRE, Assoc. M. Inst. C. E., President, in the chair, when a paper on "Steam Boiler Explosions" was read by Mr. JOHN J. WEBSTER, M. Inst. C. E., and discussed by the members. The paper commenced by stating that the average number of steam boiler explosions during the last 25 years was about 56 per annum, the average loss of life amounting to about 70 per annum, and although the number of explosions was very great, and the loss of life to be deplored, the actual percentage of explosions to boilers at work was very small, being at the rate of one explosion to every 2,500 boilers at work. Owing to the good work of the different boiler associations, and to the immense improvement in the design and construction of boilers, this percentage had now been reduced to less than one in 6,000. The paper then described in detail the various causes of boiler explosions under the following heads (1), bad material; (2), defective design, including the mountings and fittings; (3), bad workmanship; (4), careless and improper working; (5), neglect of periodical inspection; (6), bad maintenance. The paper then described some interesting physical phenomena, which had given rise to a novel theory of boiler explosions, and after discussing the question of simultaneous boiler explosions, concluded with a brief review of the existing and proposed legislation on the subject. The paper was illustrated by numerous wall diagrams. As several members desired to take part in the debate the discussion was adjourned.

PUBLICATIONS RECEIVED.

The Sabula Draw by Graphics. A Practical Illustration of the Application of Graphics, and Comparison with Analytical Methods. By MALVERN A. HOWE, C. E. The American Engineer, Chicago. 8 vo., 35 pp. 9 plates.

Graphical Analysis of Roof Trusses; for the use of Engineers, Architects and Builders. By CHAS. E. GREENE, A. M., Prof. of Civil Engineering, University of Michigan. New York, John Wiley & Sons, 1885, 8vo., 64 pp., 3 plates, tables. A new edition of a useful manual which we have heretofore noted.

Principles of Dynamo Electric Machines and Practical Directions for Designing and Constructing Dynamos. With an Appendix Containing a Table of Equivalents of Units of Measurement. By CARL HERING. New York. W. J. Johnston, 1888, Cloth, 279 pages, 59 illustrations, Price, $2.50. This is the latest American publication issued on the rapidly growing subject of Electricity. The author, a graduate of the University of Pennsylvania, has for several years been a close and earnest student of the mysteries of his favorite science; a practical experience as an Electrical Engineer in Frankfort, Germany, coming soon after graduation from college, has been supplemented by experience and study in America, until Mr. HERING may be fairly esteemed an expert in electrical matters. In his book, the author very sensibly omits the usual elementary treatise on the subject in hand and proceeds at once to the object of his work as specified in the title. The book is essentially for "Engineers and Machinists practically engaged in designing, constructing and repairing dynamos, as well as amateurs, students of Electrical Engineering and Electrical artisans" and as such it is sure to be the popular hand book. A very full index is given; the mechanical work on the book is very creditable to its publisher, and the price is placed at a figure which insures for it a wide demand among electricians.

The Legal Relations Existing between Water Companies and Consumers, and Is Water Property? This pamphlet is a reprint of two papers by A. H. DENMAN, Attorney, of Des Moines, Ia., read before the seventh annual meeting of the American Water-Works Association, at Minneapolis, Minn., 1887. The first paper deals with the legal relations, numerous cases being mentioned and references given to suits. It treats with the subject under the following heads: Company compelled to furnish water to those who apply: Consumers must comply with reasonable requirements; Measure of damages for refusal of water and for cutting off the same: Obligation and liability of the water company in case of conflagration; Apportionment of charges for water furnished by companies or by the city; Discrimination in charges for water; Domestic purposes; Meters.—The second paper is a very complete consideration of the question of the ownership of the water appropriated by water companies.

Copies of this pamphlet, which is of interest to everybody connected in any way with water supply, can be obtained of J. H. DECKER, Hannibal, Mo. Price 10 cents.

AMONG the illustrations for the article on "Modern Explosives", in the May *Scribner's*, will be four fine wood engravings of the Flood Rock explosion, made from instantaneous photographs, and also a view of the blowing up of the schooner "Joseph Henry," at the Newport Torpedo Station, in 1884.

The Testing of Materials of Construction. A Text-Book for the Engineering Laboratory and a Collection of the Results of Experiment. By WILLIAM CAWTHORNE UNWIN, F. R. S., Mem. Inst. C. E., etc. Longmans, Green & Co., Publishers, 1888. 488 pp., 141 cuts, 5 plates. Many unnumbered tables. Fair index.

This volume is another evidence of the growing tendency to compile works limited to specific and very limited branches of engineering work, made necessary by the vast expansion of engineering as a whole. It is, perhaps, more elaborately and expensively got up than the narrow limits of the subject demand, being printed in very large type, with wide margins, on very heavy paper, but it is, nevertheless, a most valuable working manual, containing a large part of the more valuable information at present obtainable from American, English or German sources relating to the testing of materials, all conveniently arranged; and it has, moreover, a wider range than its title implies, in that it is largely devoted to the results of experiments as well as to their processes; in other words it is, in part, a treatise on the strength of materials. The book is not extensive enough to be complete in this field, but it is likely to be of great service to everyone engaged in testing materials, and a useful work of reference to engineers generally. The work consists of three parts, the first of 56 pages devoted to the general theory of the mechanical properties of materials; the second, some 200 pages, to the details of mechanical testing and apparatus therefor, and the third, some 224 pages, to a summary of the results of tests in cast and wrought-iron and steel, copper and its alloys, timber stone, brick, lime and cement, and on the results of repetition of stress. A very good and valuable connected account of WÖHLER'S, SPANGENBERG'S, BAKER'S, and BAUSCHINGER'S experiments is given, which is, on the whole, the best we know of.

On the other hand, there are not a few yawning voids in the volume, especially in the part devoted to strength of materials, as we may most quickly illustrate by stating that the recent important report and recommendations of a committee of the American Society of Civil Engineers, on the subject of "Uniform Tests of Cement" is not even alluded to, nor Mr. ELIOT C. CLARKE'S valuable paper, before the same society, on the tests for the Boston Main Drainage Works, which is, in several respects, more complete, if we are not mistaken, than the treatment of the same subject in the general report on the same works which is quoted from, and which is certainly more conveniently accessible, to foreign engineers especially. It seems to us that the gaps are especially noticeable in regard to American tests, although a large amount of the newest and freshest American data is given, as is necessary from the vast amount of such work which has been done in this country in recent years. But the work is a most valuable one, and in part fills a gap which no other work does, so that we can cordially recommend it to those interested, despite the fact that we cannot endorse it as all that might be desired. Few book are.

CORRECTION.—On page 346 *ante*, in the resolution of thanks tendered to Mr. WHITELAW for the paper read at the City Hall, after the words "working model" there should have been inserted "of the inlet crib".

CONSTRUCTION NEWS.

RAILROADS.

(For news from the divisions "East of Chicago" and "The South" see page 370).

THE NORTHWEST.

Existing Roads.

Chicago & Northwestern.—Tracklaying is in progress on the Champion extension at the rate of a mile per day.

Chicago, Santa Fé & California.—A traffic contract has been made with the Chicago, Rock Island & Pacific by which Santa Fé trains will enter Peoria, Ill.

Lake Erie & Western.—The last rail has been laid on the extension from Bloomington to Peoria. The deep cut near the crossing of the Illinois river has delayed the completion of the work. It is reported to be the largest excavation in the State.

Duluth, South Shore & Atlantic.—Tracklaying is in progress on the western end of the line and 20 miles have been laid from Ashland. About 22 miles remain to be laid to bring the road to a junction with the Northern Pacific.

Indiana & Illinois Southern.—

SULLIVAN, Ind., April 18, 1888.

EDITOR ENGINEERING NEWS:

The Indianapolis & Southwestern Railroad is intended to be a line leaving our present road about 6 miles east of Sullivan, Ind., and from there running to Indianapolis *via* Jasonville, Cataract, Quincy, Eminence, Monrovia and Mooresville. The western extension leaves our present line about a mile west of Newton, and runs *via* Mason, Vernon and Tamalco, crossing the Vandalia at Highland in Madison Co., and running from there almost due west to the American Bottoms, thence to East St. Louis. The total length of this line is about 241 miles. Right of way is now being secured. W. H. ALLEY is President, and A. B. FITCH is Chief Engineer.

P. H. BLUE, *General Manager.*

Minneapolis, Sault Ste. Marie & Atlantic.—It is announced that a deal has been concluded by which this company is consolidated with the Minneapolis & Pacific and the Aberdeen, Bismarck & Northwestern companies under the name of the Minneapolis, St. Paul and Sault Ste. Marie. It has long been known that the stock of all three of these companies was largely held by Messrs. WASHBURN, PILLSBURY and LOWRIE, so the present move can cause little surprise. It is also stated that the Canadian Pacific owns largely of the company's stock.

New Projects and Surveys.

Springfield & Southern.—President RAMSEY of Carlyle, Ill., has been trying to enlist capital for this enterprise in New York City, and an examination of the proposed line is to be made by capitalists interested, during the present month.

THE SOUTHWEST.

Existing Roads.

St. Louis, Arkansas & Texas.—The annual meeting of this company was held at St. Louis on April 30. The officers of the company are anxious to build the extension which has been surveyed from Malden, Mo., to St. Louis, crossing the Mississippi at Grand Tower, but the prospects for floating bonds to raise the money for the work have been so unfavorable that no definite steps have yet been taken toward their issue. There can be no doubt that it would be greatly to the advantage of the company to secure an entrance to St. Louis, and were it not that its former financial ill repute still clings to it, there would probably be no difficulty in securing the necessary funds.

Atchison, Topeka & Santa Fé.—A station is to be erected at Wichita, Kan., at a cost of about $60,000.

Texas Central.—The company has secured an entrance to Fort Worth, Tex., over the tracks of the Texas & Pacific road.

Paragould & Buffalo Island.—Five miles of this Arkansas road are ready for the rails.

Chicago, Rock Island & Pacific.—The company has effected an entrance to Kansas City and made connection with the tracks of the Kansas City, Fort Scott & Gulf.

San Antonio & Aransas Pass.—The citizens of Rockport, Tex., are trying to secure an extension of this system to that point.——President LOTT has agreed to build the extension from Yoakum to Austin for $10,000 additional subsidy.

Chicago & Alton.—An Associated Press dispatch is going the rounds of the daily papers stating that the company intends to retaliate for the construction of the Chicago, Santa Fé & California by building a line from Kansas City southwest into Santa Fé territory. If the extension is to be built simply for revenge, we sincerely hope, in the interest of all parties concerned, that it will never be constructed. The only railroad lines that should be built are those which will pay a fair rate of interest on the capital expended in their construction, either directly or as feeders to other lines. There is little probability that the Alton is planning railroad building merely for revenge.

Missouri, Kansas & Texas.—Much interest has been excited in Wall Street over JAY GOULD'S letter claiming that the company is far behind in its interest account and in the reply of the bondholders' committee. That its financial prospects are so bad as Mr. GOULD insinuates seems improbable. The road crosses Indian Territory, and with the opening up of that fertile region to settlement and cultivation, a work which will not be many years delayed, it will be able to secure the best of its traffic. It would form an excellent opening to the Southwest for some of the great Northwestern systems, and would really be of more importance to them than to the Missouri Pacific, its present lessee, as that system controls an independent line to Texas. Default was made on the interest due on May 1 on the bonds of the International & Great Northern company, and it will probably be placed in a receiver's hands.

Houston & Texas Central.—Mrs. HETTY GREEN, who has been fighting the reorganization of the company, has finally assented to the new conditions and made an honorable surrender. A compromise was agreed upon by the bondholders' committee whereby in consideration of the size of Mrs. GREEN'S holding—$1,250,000—she was permitted to come in on the same terms as the bondholders who first assented to the reorganization plan.

New Projects and Surveys.

New Orleans, Natchez & Ft. Scott.—It is reported that President JOHN H. RICE has closed a contract with a Chicago syndicate for the construction of the road, the final location to begin on Sept. 1. Similar statements in reference to this line have been so frequently made, however, that we think it well to wait fuller confirmation of the report before placing much reliance upon it.

Ash Grove, Aurora & Eureka Springs.—A projected railroad is awakening some interest in these Missouri towns. There is some prospect that the Kansas City, Ft. Scott & Memphis system will aid the enterprise.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Portland & Willamette Valley.—

PORTLAND, Oregon, April 28, 1888.

EDITOR ENGINEERING NEWS:

Track was laid during last year on the extension of the Portland & Willamette Valley Railroad from Elk Rock to Portland, a distance of 5.8 miles; and since Jan. 1 of this year the line has been extended 2,100 ft. farther into the heart of Portland, and an extension of 1¼ miles has been built from Dundee Junction to Fulquartz on the Willamette river, distant exactly 30 miles from the company's terminus at the Public Levee in the city of Portland.

WILLIAM REID, *Vice-President.*

San Diego, Cuyamaca & Eastern.—Ground was broken on this California road on April 24 at San Diego by the President of the company, ex-Gov. WATERMAN.

Santa Ana, Fairview & Pacific.—Grading is completed on this California line from Santa Ana to Fairview and it is expected that the road will be open for business by June 1.

Los Angeles County.—W. T. Spillman has the contract for grading from Sunset to Santa Monica, Cal., about 6 miles. The grade for a branch to Burbank has just been completed.

Northern Pacific.—Probably by the time this issue reaches our readers the Cascade tunnel will be completed, as the headings were expected to meet on May 3. The traffic reports for the first three months of the year have been very gratifying, and the constant increases in earnings are bringing the company's securities into better favor. There is a prospect that a line will be built at an early day from Cheney, W. T., to Yakima.

Southern Pacific.—Ground has been broken for large extensions to the company's shops at Sacramento, which will give an additional floor space of about two acres. The boiler shop, machine shop, car shop and paint shop are to be enlarged, and a new car shop and an oil house are to be built.——Trains are running to within 10 miles of Santa Rosa on the Santa Rosa & Carquinez extension.——About 38 miles of the extension from Tracy in the San Joaquin Valley is soon to be opened for business.——The company has filed a charter for a line to run from Avon on the San Pablo & Tulare Railroad to a point on the Central Pacific near Pleasanton, Alameda county, to be known as the San Ramon Valley Railroad. A charter has also been filed for the Ramona and San Bernardino railroad to run from Ramona to Crafton, about 71 miles.——The annual report of the Central Pacific shows that the Southern Pacific company operated the line at a loss the past year.

San Francisco & Northern Pacific.—The San Francisco *Call* announces that Col. DONAHUE, the principal owner of this road, has been negotiating for the sale of the entire property to Gen. JOHN MCNULTA, the Receiver of the Wabash. The negotiations, however, have fallen through and it is said that another syndicate will probably obtain control of the line. It is stated that Gen. MCNULTA will probably abandon the San Francisco, Clear Lake & Humboldt enterprise as a result of the failure of his negotiations for the Donahue system.

San Francisco & San Joaquin Valley.—No grading is at present in progress on this California road but a force is at work building a wagon road through Tejon pass, and a corps of engineers is running lines from Dutch Corners north toward Corral Hollow.

Vancouver, Klickitat & Yakima.—The first five miles of this Washington Territory road are ready for the rails.

Missouri Pacific.—The Pueblo & State Line was made a part of the Missouri Pacific system at the meeting of its stockholders on April 26. It is stated that work will begin soon on the extension from Pueblo southwest to the coal fields, about 40 miles of which are to be built this year.

Union Pacific.—President ADAMS stated at the annual meeting that unless the company issued bonds to raise the money, no new extensions of importance would be built this year.

New Projects and Surveys.

Ilwaco Steam Navigation Co.'s Railroad.—

29 Washington St., PORTLAND, Oregon, April 23, 1888.

EDITOR ENGINEERING NEWS:

This line is to run from Ilwaco (Baker's Bay, mouth of Columbia river) to Shoalwater bay (due north) along the beach, a distance of 16 miles. The line is now under construction by the company, no contracts being let. Work is generally very light and the only works of size are two wharves 3,000 ft. long at the termini of the road. L. A. LOOMIS is President of the company.

F. E. HABERSHAM, *Chief Engineer.*

Oregon Land & Investment Company.—This company is obtaining right of way for a suburban railroad at Portland, Ore.

Copper Queen Mining Co.—This Arizona company proposes to construct a railroad from its mines at Bisbee *via* Tombstone to Fairbank, a distance of 35 miles.

San Luis Obispo & San Joaquin.—This proposed California road has received subscriptions to the amount of $230,000. H. P. SWEET of San Luis Obispo is interested.

El Paso, White Oaks & Kansas City.—A press dispatch from El Paso, Tex., dated April 27, says:

H. L. NEWMAN, Vice-President of the El Paso, White Oaks & Kansas City Railroad, arrived to-day from San Francisco, where he has been in conference with Morris Locke & Co. and the Southern Pacific Railway officials in the interest of the White Oaks Railway. Vice-President NEWMAN says that Morris Locke & Co. will arrive here next week with their engineers to go over the line of the proposed road to White Oaks, in order to begin actual work. Mr. B. F. HAMMETT, President of the same road, will arrive here to-morrow.

Spokane Falls & Northern.—This company has been incorporated in Washington Territory to build a line from Spokane Falls north to the Columbia river. Among the incorporators are A. E. JEFFERSON of Hudson, Wis., D. C. CORBIN, of the Coeur d'Alene Ry. & Navigation Co., JAS. N. GLOVER, W. H. TAYLOR and F. J. BRICKELL, Presidents of the Spokane Falls Banks.

Contracting.

Water Pipe.—The contract for cast-iron pipe and specials has been awarded by the Executive Board, Rochester, N. Y., to the Donaldson Iron Co., Emaus, Pa. The list of bids was given on page 324.

Rock Drills.—A paper on "The New Croton Aqueduct", by LEE TREADWELL, of Fayetteville, Ark., read at the annual meeting of the Arkansas Society of Engineers, contains a table of the highest record in single hea ling, with different drills, for the 4 months previous to July 3, 1886.

Cross Ties.—The following proposals for 1,000 sound chestnut, white oak or rock oak cross ties, 6½ ft. long, 6 ins. face and bottom and 5½ ins. thick, were received April 23 by the Lancaster & Millersville Ry. Co., at Lancaster, Pa.: B. F. Herr, Refton, Pa., 22 cts.; John McFalls, Smithville, Pa., 23¾ cts.; Geo. S. Wise, Ephrata, Pa., 32 cts.; A. E. Rauck, Dunmore, Pa., 51½ cts. The contract was awarded to B. F. Herr.

Jail.—The following were the bids received at Louisville, Ga., for brick jail with 2 steel clad cells, 2 insane cells and all appliances, etc., complete: L. B. Artope, Macon, Ga., $4,400; John D. Ford, Macon, Ga., $4,480; Van Dorn Iron Works, Cleveland, O., $4,750; Pauly Jail Mfg. Co., St. Louis, Mo., $4,873; C. E. Hamlin, Chattanooga, Tenn., $5,750; Chas. Sunburg & Co., Chicago, Ill., $8,461.

River Improvement.—The following proposals for the construction of Lock No. 1 on the Black Warrior river, Alabama, were opened April 21 by Major A. N. DAMRELL, U. S. Engineer Office, Mobile, Ala.: J. A. & J. Smith, Cincinnati, O., $172,061.87; Reilly & Gude, Atlanta, Ga., $162,557.87; L. M. Petitdidier, Cincinnati, O., $161,448.75; a bid from Birmingham, Ala., without signature or bond, was for $97,610.80. All bids were rejected as too high.

Iron Work.—THEODORE COOPER, M. Am. Soc. C. E., has received bids for 1,000 tons of girder work for the elevated trestles, platforms and canopies of the Union depot at Hartford, Conn. The contract was let to the Penoyd Bridge Co. The depot is being built jointly by the city of Hartford, the New York, New Haven & Hartford R. R. and the New York & New England R. R. companies.

Harvard Bridge Abutments.—The following proposals for the masonry abutments of the Harvard bridge, across the Charles river, between Boston and Cambridge, Mass., were opened April 25 by the Harvard Bridge Commissioners, City Hall, Boston: Boynton Bros., Boston, $13,255.65; William H. Ward, Lowell, $15,900; Charles H. Edwards, Quincy, $18,557; Shields, Carroll & Neelon, Toronto, Ont., $19,659.61; Thomas A. Rowe, Newton, $22,500; George S. Barnes, Boston, $31,012. The contract was awarded to William H. Ward.

The American "Devil."—The human navvies at work on the Manchester Ship Canal cutting call their American "mate" the American devil. His feats are thus graphically described by a special correspondent: The steel monster faces the steep bank. His lip trifles for a little tentatively, as it were, with the cliff base. And then up goes the "devil's" head, and his four steel teeth tear their way through the 23 ft. of sand, clay, gravel, marl. His mouth holds a cubic yard, which means a ton and a half. There are trucks on either side of him. Two of his mouthfuls are as much as a truck can hold. When he loads one he wheels round about and operates upon another. *Ironmongery.*

Dam.—The following proposals for the construction of a reservoir dam for the Southbridge Water Supply Co. have been received by A. C. MOORE, C. E., Southbridge, Mass.: Thomas Hennessey, Holden, Mass.; earth excavation, 50 cts. per cu. yd.; filling, 50 cts. per cu. yd.; dry rubble, $3 per cu. yd.; rubble in mortar, $4 per cu. yd.; concrete, $7 per cu. yd.; lumber, $30 per 1,000 ft. B. M.; total, $3,797. I. R. Rooke, Fayville, Mass., 40 cts., 64 cts., $2.50, $4, $3.15, $35, $3,869.50. G. W. & J. M. Hendrick, Easthampton, Mass., total, $4,000. Wellington & Kimball, Burrillville, R. I., 50 cts., 50 cts., $4, $6, $5, $30, $4,100. H. H. Pike & Co., Cambridge, Mass., $1, $1, $6, $10, $10, $40, $7,863. The contract was awarded to Thomas Hennessey.

Railways in Chili.—Proposals will be received until July 30 by the Department of Industry & Public Works, Santiago, Chili, for the construction of a number of railways, as follows: Section A., from Victoria to Valdivia and Osorno, 250 miles. Section B, from Coihue to Mulchen, 26.6 miles; Tome to Cauquenes and to the Central line, 124 miles; from Constitucion to Talca, 52.7 miles; from Palmilla to Alcones, 28 miles; from Pelequen to Peumo, 17.3 miles; a total of 248.6 miles. Section C, from Santiago to Melipilla, 36.6 miles; from Calera to La Ligua and Cabildo, 47 miles; from Los Vilas to Illapel and Salamanca, 79.4 miles; from Ovalle to San Marcos, 37.2 miles; from Huasco to Freirina and Vallenar, 29.8 miles; a total of 230 miles. Proposals may be for the three sections together, or for each section separately. All material will be imported free of duty. Further information can be obtained at the Chilian Legation, Washington, D. C.; Chilian Consulate, Boston, and the Chilian Consulate, 15 Cortlandt St., New York City.

Stampede Tunnel. Northern Pacific R. R.—The Stampede Pass tunnel, which pierces the Cascade mountains in Washington Territory, was broken through on May 3. The contractor was Nelson Bennet, who commenced work in April 1886, but slow progress was made at first owing to the difficulty of hauling materials and getting men. The tunnel is 9,800 ft. long, 20½ ft. high and 16 ft. wide; there are no air shafts. At the east end the plant consists of four 70 H. P. boilers, 2 Ingersoll and 1 Clayton compressors, a Leffel water wheel, exhaust fan, 45 H. P. engine, 15 Ingersoll "Eclipse" drills, 1 trimming drill, 1 Porter locomotive, etc., with machine shops, electric light, and a number of buildings. The plant at the west end is similar, except the Clayton compressor.

Foot Bridge.—The following proposals for a foot bridge in Forest Park have been received by HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo.: A. J. Tullock, $1,450; M. Stupp, $1,489; King Iron Bridge & Manufacturing Co., Cleveland, O., $1,493; Carondelet Boiler & Sheet Iron Co., $2,128.

Pier.—The contract for the new pier, No. 62, at the foot of W. 32nd St., New York City, for the New York Central & Hudson River R. R. Co., has been awarded to Jones, Benner & Co., of Philadelphia, for about $48,385. The pier will be of iron, and will be 500 ft. long and 60 ft. wide.

Sewers.—The following proposals for the construction of brick sewers have been received by the Board of Public Works, Bridgeport, Conn. The contract was awarded to John Barr.

Bidders.	210 ft. Manholes, per lin. ft.	2345 ft. Sewers 24 × 36 per lin. ft.	3892 ft. Sewers 33 × 49½ per lin. ft.	1300 ft. Sewers 40 × 60 per lin. ft.	800 cu. yds. Rock Exc. per cu. yd.	200 ft. Piling per lin. ft.	Totals.
John Barr	$1.25	$3.30	$4.85	$5.38	$1.40	$2.60	$35,516.20
M. A. Austin	1.50	3.75	4.75	5.25	4.00	3.00	38,226.75
Chas. B. Caldwell	1.50	3.50	4.95	5.35	3.50	4.00	38,348.90
L. J. Wright	1.50	3.75	4.80	5.75	3.50	2.00	38,471.35
G. W. Judd	1.75	3.59	5.07	5.95	4.35	2.73	40,286.49
H. D. Pierce, Jr.	.90	3.96	5.23	6.10	3.75	1.86	41,135.96
Jacoby & Madden	2.00	3.10	5.65	6.25	5.00	2.50	42,312.30
Metropolitan Construction Co	1.35	4.07	5.55	6.57	3.95	2.95	43,720.37
John B. Healey	3.50	5.00	6.00	6.25	3.95	4.00	47,911.00
W. E. Dean	3.00	5.25	7.60	8.10	4.00	3.00	56,862.45

The Chapman Valve Mfg. Co., of Indian Orchard, Mass., has opened an office and salesroom at 24 W. Lake St., Chicago.

The Minneapolis Pump Co. has been incorporated by A. T. SHEAREB, H. L. EGELL and L. C. FARMER. Capital stock, $200,000.

The Ingersoll Rock Drill Co., of New York City, has shipped to Barcelona, Spain, a line of mining machinery, with catalogues and circulars printed in English, Spanish and French, to be exhibited at the International Exhibition which will be opened this month, and continue for about 6 months.

Submarine Cables.—The following contracts have been awarded by Gen. GREELY, Chief Signal Officer, War Department, Washington, D. C.: Cable to Martha's Vineyard, Mass.; 6¾ nautical miles of 2 conductor cable, and 1¼ nautical miles of 1 conductor cable; E. S. Greeley & Co., New York, $9,006.69.—Cable at the Columbia river, Oregon; furnishing, delivering and laying 4 nautical miles of cable; Western Electric Co., $4,960.

Sewerage.—All the bids for the sewerage system for Raleigh, N. C., which were opened April 16, were unsatisfactory and consequently all were rejected, thus delaying the matter. Propositions to take the contract will be received and considered at any time by the Sewerage Committee. J. L. LUDLOW, of Winston, N. C., is the engineer.

Railway Contracts.—***Cincinnati, Hamilton & Dayton.***—Contracts have been let for the construction of the first section of the extension from McComb to Findlay, O.

Roanoke & Southern.—Breen & Frelly, of Alexandria, Va., have the contract for 14 miles south from Martinsville.

Lynchburg & Durham.—The contract for the first 10 miles from Rustburg, Va., has been awarded to C. S. Moorman & Co.; for the next 14 miles to Serpell & Co.; from the Staunton river to South Boston, to Carrington & Kelly, and for the masonry of the Staunton river bridge to C. Rosazza.

Cincinnati, Charleston & Chicago.—Contracts have been let to Hampton Bros. for 6 miles, and to P. J. Sinclair for 7 miles. Also to Joseph Mills and Wm. H. Kirby.

Oregon Railway & Navigation.—Kilpatrick Bros. & Collins, contractors for the Heppner and Eureka Flat branches, have sublet all the work. The Heppner branch will be built by J. H. Smith, of Portland, Ore., and Thos. Jessop of Utah. The Eureka Flat branch will be built by Corry Bros., of Ogden, Utah.

Ilwaco & Shoalwater Bay.—Messrs. Hawgood & Habersham write as follows from Portland, Ore.: "Bids were opened April 14 for the construction of 3,000 lin. ft. of wharf and trestle, and also 16 miles of roadbed. They ranged from $7,150 to $10,000, total cost of wharf and trestle; all bids rejected. Roadbed bids ranged from 25 to 30 cts. per cu. yd.; all bids rejected. The company will do its own work.

T. Wm. Harris & Co. have moved their offices to 44 and 46 Broadway, New York City. The firm is now constructing the Woodlawn & Butternut St. Ry. at Syracuse, N. Y., and belt lines at Savannah, Ga., for the Savannah Street & Rural Resort Ry. and the City & Suburban Street Ry. The firm is also prepared to push the Loomis gas system, which it believes to be the nearest approach, in point of economy, to natural gas.

Dikes.—The following proposals were opened April 27 by Lt. Col. HENRY M. ROBERT, U. S. Engineer Office, Philadelphia, Pa.: For furnishing and depositing stone in constructing a dike in the Delaware river at Mifflin bar; Brandywine Granite Co., Wilmington, Del., $1.75 per cu. yd.; John Satterlee, Englewood, N. J, $1.93; Jos. E. Spencer and W. W. Virdin, Lapidum, Md., $2.05; Joseph H. Ward, Ridley Park, Pa., $1.19 (informal); John A. Barker, New York City, $1.65 (informal); George R. Stephenson, Lapidum, Pa., $2.10 (informal). The prices of all the formal bids were too high and all were rejected. ——For constructing a dike in the Delaware river from the lower end of Reedy Island; Brandywine Granite Co., Wilmington, Del.; brush mattress, $1.55 per cu. yd.; stone, $1.45 per cu. yd.; total, $35,200; Ira Lunt, New Castle, Del., $1.74, $1.54, $37,760; John A. Churchill, Jr., Burlington, Vt., $1.89, $1.74, $42,360; John Satterlee, Englewood, N. J., $1.84, $1.79, $43,160; John A. Bouker, New York City, $1.70, $1.75, $41,800 (informal). The contract was awarded to the Brandywine Granite Co.

Proposals Open.

Cable Railway.—About 6 miles. H. W. MCNEILL, Chief Engineer, Milwaukee Cable Car Co., Milwaukee, Wis.

Water Supply.—Delivered into reservoirs Nos. 2 and 3 on Bergen Hill, and into the high service distribution pipes with a head of 100 ft. above high water level in the reservoirs. MARTIN FINCK, Clerk, Board of Public Works, Jersey City, N. J. May 7.

Iron Bridge.—Over the Big Blue river at Manchester. P. H. GINTER, County Surveyor, Independence, Mo. May 7.

Electric Lighting.—Lighting streets and parks. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. May 9.

Cut Stone.—THE COMMISSIONER OF PUBLIC WORKS, New York City. May 10.

Pipe, Hydrants, Etc.—Hydrants, stop cocks, 6-in. cast-iron pipe, laying water mains, etc. THE COMMISSIONER OF PUBLIC WORKS, New York City. May 10

Reservoir.—About 665 ft. long, 50 ft. wide and 11¼ ft. deep. H. P. WILKINSON, Secretary, City Water Board, Wheeling, W. Va. May 10.

Pier Work.—New wooden pier and repairing bulkhead at the foot of Jefferson St., East River. THE DOCKS COMMISSIONERS, Pier A, North River, New York City. May 10.

Water Tower.—At Mount Bellevue. THE CHAIRMAN OF THE WATER BOARD, Boston, Mass. May 10.

Railway.—Grading, crossties, and trestles (framed and on piles), for single track road from Columbus, Miss., to Johnsonville, Miss., 134 miles. Specifications, etc., at the office of the Chief Engineer, in Birmingham. JOHN W. JOHNSTON, President, Georgia Pacific Ry. Co., Birmingham, Ala. May 12.

Bridge.—Over the New river at Fayette station. E. B. HAWKINS, Fayetteville, W. Va. May 12.

Street Work.—Granite paving, May 14. Grading, curbing, guttering, Telford paving and macadamizing, May 22. HENRY FLAD, President, Board of Public Improvements, St. Louis, Mo.

Drawing Material.—For the Signal Service, Gen. A. W. GREELY, Chief Signal Officer, War Department, Washington, D. C. May 15.

Boilers.—Four tubular steel boilers. C. P. BANCROFT, Superintendent, New Hampshire Asylum for the Insane, Concord, N. H. May 15.

Road Improvements.—FRED RAINE, County Auditor, Cincinnati, O. May 23.

Revetment.—Stone revetment on the earth slopes at the locks of the Louisville & Portland Canal. Major AMOS STICKNEY, U. S. Engineer Office, Louisville, Ky. May 26.

Water-Works.—Complete system for Eureka, Kan. Plans and specifications prepared by J. W. NIER, C. E., Hall Building, Kansas City, Mo. H. A. DENNIS, City Clerk, Eureka, Kan. May 31.

Gas.—Manufacturing and delivering into city gasholders. EDWIN H. FITLER, Mayor, Philadelphia, Pa. June 5.

Bridges.—Two iron or combination bridges 60 ft. long: 8 piles (4 at each end) 16 and 26 ft. long. JACOB SCHAEFER, Chairman, Bridge Committee, Cuming Co., Neb. June 5.

Stone and Pipe.—Rubble stones: 15, 18 and 24-in. vitrified pipe. Separate bids. JOHN T. COOPER, Clerk, County Commissioners, Atlanta, Ga. June 16.

County Bonds.—Loan of $30,000. LOUIS ELWANG, County Clerk, Carlyle Clinton Co., Ill. June 11.

Plans for Public Buildings.—Plans, specifications and estimates for court house and jail at Denver, Col. Best plans awarded $300; second best, $200. JOSEPH H. SMITH, County Clerk, Denver, Col. June 11.

RAILROADS.

East of Chicago.

Existing Roads.

South Pennsylvania.—A meeting of the stock and bondholders of this company is to be held at the office of FRANCIS L. STETSON, in this city on May 9, to decide upon plans for the completion of the road. The compromise agreement is signed by the VANDERBILTS, ANDREW CARNEGIE, Dr. HOSTETTER and other of the prominent stockholders. The new agreement provides for the payment of 20 per cent. on the stock subscriptions by which $3,000,000 will be raised. There are also to be issued $10,000,000 six per cent. 50 year bonds, and it is thought the money thus obtained will be sufficient for completing the road. Contracts are to be let at once for the completion of the work. S. M. STEVENSON is Secretary of the Reorganization Committee.

Indiana, Illinois & Iowa.—An extension of 35 miles from Kout's to South Bend, Ind., is to be begun at once.

Boston, Concord & Montreal.—In the suit for the appointment of a receiver for this property, now being tried at Concord, N. H., various experts have testified as to the dangerous condition of the road. It is estimated that $250,000 should be expended at once on new rails, bridges, ties and ballasting to put the road in tolerably safe condition.

Providence & Worcester.—The directors of this company voted unanimously on May 1 in favor of the lease to the New York, Providence & Boston. The stockholders meet to ratify the lease on May 17.

Canadian Pacific.—A bill has been favorably reported by the Railroad Committee of the Dominion Parliament giving the company a charter for a line to the International boundary to connect with a branch of the Rome, Watertown & Ogdensburgh. It is reported that a traffic contract has been concluded with the Grand Trunk by which that company obtains running rights over the line from Callender to Sault Ste. Marie, while the Canadian Pacific will use the Grand Trunk tracks from St. Thomas to Detroit.——A meeting was held at Listowel, Ont., on April 24, in the interest of the proposed extension from Guelph to Goderich.

Grand Trunk.—At the meeting of the stockholders in London, April 25, Sir HENRY TYLER stated that the company would save enough interest by refunding its debt to prevent it from feeling the expense consequent on doubling the line from Montreal to Toronto, 333 miles.

Cleveland, Akron & Columbus.—A passenger depot is to be erected at Akron, O., at a cost of $25,000.

Flint & Pere Marquette.—The annual report of this company shows a gain of $412,164.97 in net earnings over 1886. The belt line around the city of Saginaw will be built this season. The right of way having been already obtained.

Cornwall & Lebanon.—It is expected that contracts will be let soon for the extension from Cornwall to New Holland, Pa.

Central Railroad of New Jersey.—The Scranton & Wilkesbarre branch was formally opened on April 30.

McKeesport & Bellevernon.—At a meeting of the stockholders on April 27, it was voted to increase the capital stock from $280,000 to $600,000. The line is to run from McKeesport, Pa., to Fayette City along the east side of the Monongahela river, about 30 miles. Grading has been in progress since last fall and about 6 miles are completed. J. WAINWRIGHT is President and W. T. WALLACE is Secretary and Treasurer.

Maine Central.—It seems to be settled that the Dexter & Newport road is to be extended to Dover and Foxcroft. ——The company has made an offer for a lease of the Portland & Ogdensburgh.

Toledo, Saginaw & Mackinaw.—The contract for laying track from Durand to East Saginaw, Mich., was let to Wiswell of Chicago and the fencing contract to Shoulters of Port Huron.

Detroit, Lansing & Northern.—Tracklaying is in progress on the extension from Grand Ledge to Grand Rapids.

Connecticut River.—The proposed consolidation of this company with the Ashuelot Railroad company is to be decided at the meeting on May 4.

Knox & South Bend.—This company has been incorporated in Indiana to build a line between the

points named, about 33 miles. C. H. SMITH, BYRON N. HASLETT, LEWIS H. MILLER and others are interested.

Carabasset Valley.—The town of New Portland, Me., has voted $1,000 in aid of a survey for a railroad from Wiscasset to a connection with the Canadian Pacific.

Clarksville & Voorheesville.—A railway is projected between these New York towns. It will be a branch of the Delaware & Hudson Canal Company's line.

Baltimore & Harrisburgh.—This company has filed a charter for its western extension which will run from Ortuawa, Adams Co., Pa., to the State line west of Blue Ridge Summit, about 15 miles.

Pennsylvania.—Little new work is to be undertaken by the company during the present year as compared with last year when about $6,300,000 was expended in extensions, additional tracks, and permanent improvements.—Negotiations are nearly closed by which the Pennsylvania Company purchases the Cincinnati, Richmond & Chicago road of the Cincinnati, Hamilton & Dayton Company at a cost of about $375,000. The Pemberton & Hightstown railroad in New Jersey, 24 miles in length, was abandoned on May 1, the tracks are to be taken up and there seems no prospect that the road will ever be opened again. The road was built 20 years ago and has never been a paying enterprise. This is one of the very rare instances in which a railroad once in actual operation is totally abandoned.

New Projects and Surveys.

Cooperstown & Charlotte Valley.—This company has been incorporated in New York to build a railroad 1¼ miles in length, by EDWIN H. HARRIS and others of Cooperstown, N. Y.

Quebec & James Bay.—One of our contemporaries says:

"This Quebec road is projected to run from some point on the line of the Quebec & Lake St. John railway in a westerly direction to the north side of Lake Abittibi, and thence to Moose factory, James bay, a distance in all of about 300 miles."

As the country between Lake St. John and James Bay is for the most part a barren wilderness into which only a few exploring parties have ever ventured, it seems probable that the day when a railroad will be built through it is very far in the future.

SOUTHERN

Existing Roads.

Norfolk & Western.—The annual report makes the following showing:

Gross earnings.....	$4,254,794	Increase.....	$1,002,737
Operating expenses.	2,483,780	"	522,870
Net earnings.....	1,771,013	"	479,866

The mileage increase during the year was 26.53 miles, and there was expended for the purposes named in the improvement and extension mortgage $1,152,569. On the Clinch Valley extension 115 miles are now under construction, and on the Cripple Creek and Elkhorn extensions 10.3 miles. The 22 miles to Tazewell C. H., on the former line will be finished by July 1, and 20 more to Richland by Sept. 1.

West Virginia Central & Pittsburgh.—The gross earnings for the first three months of 1888 are double the amount for the same period in 1887 and nearly four times as much as in the first quarter of 1886. About 200 hands are at work on the extension from Thomas toward Beverly, W. Va., about 32 miles.

Roanoke & Southern.—The Virginia & Carolina Construction Company has been formed to build this road, with W. H. FRIES, of Winston, N. C., as President, and the company has given it a 60 days option on the contract for the construction.

Georgia Southern & Florida.—About 30 miles of track have been laid from Macon, Ga., south, to the southern boundary of Houston county. Three preliminary lines have been run from Valdosta, Ga., to Palatka, Fla., and surveyors are now at work on a branch to Thomasville, to tap the main line at some point between Vienna and Tifton and to be about 40 miles in length.

Nashville & Knoxville.—At the stockholders' meeting at Lebanon, Tenn., on April 25 the old Board of Directors we reelected, including A. J. CRAWFORD, of Terre Haute, Ind., L. S. HOYT, of New Castle, Pa., and J. N. HAMILTON, of Nashville, Tenn. It was voted to issue $2,000,000 first mortgage bonds at the discretion of the directors. Tracklaying is in progress at the rate of a half mile per day. An offer has been made by the company for the building of a branch from Brush Creek to Alexandria and the subsidy asked will doubtless be given.

Richmond & Wicomico Wharf.—A company has been formed at Richmond, Va., to build a railroad to Wicomico Wharf opposite Crisfield, Md., and a deposit of $5,000 has been made with the city to guarantee the commencement of work within 60 days, and the completion within three years as provided in the charter. The line has been surveyed and some grading has been done. The road will enter the city by a tunnel on Eighth St., three-fourths of a mile in length.

New Projects and Surveys.

Montgomery & Maplesville.—President W. L. CHAMBERS is reported by the Montgomery *Advertiser* as stating that no further work will be done on this line at present. The preliminary surveys which have been made will not be followed up by further work unless the people of Montgomery conclude to grant aid to the line.

Chester & Camden.—This South Carolina line is under survey.

Chicago & Gulf Air Line.—A charter has been filed in Tennessee for this projected road which is to run from Chicago to Mobile, Ala. The incorporators include AMASA MASON, SILAS W. COCHRAN, and JOHN B. FISKE of New York City, the same parties who are interested in the Paducah & Mt. Vernon and Chicago, St. Louis & Paducah enterprises in Illinois.

Wadesboro, Winnsboro & Camak.—This project, which has been discussed at intervals for many months, has been organized, and a banquet was recently given at Winnsboro, S. C., in honor of the incorporators.

Burgaw & Jacksonville.—GEO. A. RAMSAY of Pender, N. C., proposes to construct a railroad between the points above named, about 28 miles.

Bristol & Danville.—This Virginia company has been organized with JOHN M. BAILEY, of Bristol, Tenn., President of the South Atlantic & Ohio Railroad, at its head.

Selma Land Improvement & Furnace Co.—This company at Selma, Ala., has subscribed $91,500 to the stock of three railroad companies, the Selma & Cahaba Valley, the Atlanta & Alabama, and the Selma & New Orleans.

WATER.

Water for Fire Purposes.—As nearly as can be estimated, 36,619,000 galls. of water were used in 1887 by the land engines of the New York Fire Department in extinguishing fires, including the quantity taken from the rivers; and in addition thereto an estimated quantity of 4,800,500 galls. of river water was used by the two floating engines, making an aggregate of 41,419,500 galls.

Louisville, Ky.—The contract for the pumping machinery has been awarded by the Louisville Water Co. to I. P. Morris & Co., of Philadelphia, Pa., for $235,000. The engine will be an independent, compound, beam and fly wheel, surface condensing engine of the Leavitt type, working two differential, double acting plunger pumps; its daily capacity will be 16,000,000 galls. The high pressure cylinder will be 27 ins. diameter, low pressure 54 ins., stroke 10 ft. The flywheel will be 36 ft. diameter and weigh 57 tons. There will be 3 tubular boilers, 84 ins. diameter 32 ft 8 ins. long, with Belpaire fireboxes; they will weigh 70,000 lbs. each. The total weight of the entire plant will be about 2,000,000 lbs.

Gas Supply of Philadelphia, Pa.—The city has issued a circular with regard to the proposed transfer of the city gas works to contractors. The ordinance approved April 6 authorizes the mayor to make yearly contracts for the manufacture and delivery into the city's gas-holders of not more than 3,000,000 cu. ft. of illuminating gas per day, 6 months notice to be given to the contractor of any additional quantity. The gas to be not less than 22-candle power, and the price not to exceed 50 cts. per 1,000 cu. ft. The works to be erected at approved sites. The gas will be measured by meters, and monthly payments made. In accordance with this ordinance proposals have been advertised for and will be received by the mayor, Hon. EDWIN H. FITLER, until June 5. Bidders must submit detailed drawings and specifications of proposed works and buildings, with full description of processes and patents. Proposals must state the following particulars: Style and title by which the gas is generally known: Where the processes are in operation and where they have been used: When these operations were begun: Candle power of gas: Maximum per cent. of carbonic oxide: Price per 1,000 cu. ft. for first year and subsequent years: Maximum price of appliances covered by patents; When work will be begun, and when gas will be delivered into the holders. The circular contains a plan of the city works in the 25th Ward, where the first plant is to be erected.

Roanoke, Va.—W. W. COE, has made a report to the Committee on Sewerage favoring the adoption of the plans suggested by RUDOLPH HERING to the Roanoke Land & Improvement Co. in 1892. This estimate is as follows:

6,600 lin. ft. of 24-in. pipe, at $1.60 per ft.....	$10,560
3,200 lin. ft. of 15-in pipe at 75 cts.....	2,400
3,400 lin. ft. of 12-in. pipe, at 50 cts.....	1,700
6,000 lin. ft. of 6 and 8-in. pipe at 40 cts.....	2,400
Inlets, outlets, "T's", "Y's" and elbows.....	1,000
100 man-holes.....	2,500
Total.....	$20,560
Add for engineering, superintendence and contingencies.....	3,440
Total.....	$24,100

He recommends that the preparation of detail plans and the general supervision of the work be entrusted to a sanitary engineer of experience in his special line, who should be associated with the City Engineer.

Sewerage.—*Marlboro, Mass.*—The legislative committee on sewerage has visited the town to look over the system of water-works, to consider the plans of the town for a sewerage system, and to investigate the proposed plan of disposing of the sewage by filtration.

Wayland, Mass.—A committee has been appointed to investigate and report upon the question of establishing a system of sewerage.

East Orange, N. J.—The Sewerage & Drainage Committee recently examined the sewage disposal works and reported that it found them in a very satisfactory condition.

Baltimore, Md.—The inhabitants of Northwest Baltimore have petitioned that $700,000 of the improvement loan of $5,000,000 should be devoted to sewerage in their district.

Coldwater, Mich.—Sewers will probably be built this season. The plans and specifications prepared by MASON I. BROWN, C. E., of Detroit, have been accepted.

Bismarck, Dak.—A complete and efficient sewerage system is much needed, the present system being entirely inadequate.

Colorado Springs, Col.—It is proposed to issue bonds for $50,000 for a system of sewerage.

Water-Works.—*Rhode Island.*—Barrington. The Drownville Water Co. has been organized under a charter recently granted by the Legislature. President, D. A. WALDRON; Secretary, CHARLES F. ANTHONY. Capital stock, $10,000.—Burrillville. The committee appointed to consider the question of a water supply has voted in favor of making a contract with the Burrillville Water Co. The supply will be by gravity from Wallum pond. It is recommended that an engineer be employed to prepare surveys and estimates. The company's proposition provides for an annual rental of $4,000 for 125 hydrants; also two hose carts and 1,000 ft. of hose. The town can issue bonds for $75,000. The question will be put to public vote.

Massachusetts.—Abington. It has been voted to issue bonds for $30,000 for extending the water-works towards West Abington.—Newton. The Common Council has appropriated $2,167 for water mains.—Hyde Park. An appropriation of $5,250 has been made for hydrants.

Connecticut.—Waterbury. Quassapaug lake is recommended as the ultimate source of the water supply. The lake is about 1¼ miles long by 1 mile wide, and the property will cost about $100,000.

New York.—Unadilla. During 1887 there were 3,200 ft. of pipe laid and 3 hydrants put in.

New Jersey.—Montclair. The last installment of the $1,000,000 capital stock of the Montclair Water Co. has been paid in.—Moorestown. The new works are expected to be in operation in July. The water tower and tank will be 170 ft. higher than the reservoir, which is 99 ft. above tide level.

Pennsylvania.—Towanda. The town has been authorized to issue bonds for $30,000 for a system of water-works.

Tennessee.—Nashville. The new water-works, will be completed early in the fall. The works, including filters, etc., will cost about $1,000,000.

Kentucky.—Paris. The water works, the contract for which has been awarded, will be built by J. E. THOMPSON.

North Carolina.—Tarboro. Water-works are projected. Address O. WILLIAMS for particulars.—Greensboro. No bids were received April 25, in answer to the advertisement for proposals for water-works. N. O'BERRY, Water Commissioner.

Alabama.—Sheffield. The Sheffield Iron, Coal & Land Co. will enlarge its works.—Sylacauga. A reservoir is to be built to furnish a water-supply for fire purposes.

Illinois.—Bushnell. A vote will be taken May 7 on the issue of bonds for water-works.

Colorado.—Denver. Owing to the scarcity of water from the mountain streams from which the supply for fire purposes is derived, it is proposed to purchase two new steam fire engines.—Montrose. It has been voted to issue bonds for $50,000 for a system of water-works; but no preparations have yet been made towards letting contracts.

Nebraska.—Orleans. Steps will be taken at once toward constructing the water-works; bonds having been voted. Apply to the City Clerk for particulars.

Washington Territory.—Asotin. The Asotin Water-Works Co. has been incorporated by E. BAUMEISTER, W. H. REID and J. W. CLEMENS.

Oregon.—Coquille. The North Coquille Water-Works Co. has been incorporated by R. D. SANDFORD and others.

California.—Marysville. The main building of the water-works, which was destroyed by fire last fall is being rebuilt. The tank will be at a greater elevation and almost double the capacity of the old one.—National City. At the opening of the water-works April 18, four ¾ in. streams were thrown to a height of 100 ft.

Canada.—Toronto. It is proposed to establish a system of water works for the northern suburbs of the city, with a daily capacity of from 500,000 to 1,000,000 galls. There will be about 15,000 ft. of 4-in. mains and 30 hydrants. The supply will probably be pumped to a

reservoir, and direct pressure used for fire purposes. C. D. WARREN is interested. The present requirements would not for some time to come necessitate the working of the pumps to their full capacity.—Montreal. The Water Committee has asked the Council for an appropriation of $95,000 from the water-works loan for carting and laying iron water mains.

Electric Light & Gas.—*Tilton, N. H.*—The village is now lighted by 15 arc lights, and several incandescent lights have been put in offices and residences. Two dynamos are driven by a 200 H. P. turbine.

Great Falls, N. H.—An electric light company has been organized. H. S. CHASE, Superintendent of the Gas Light Co., is interested.

Danvers, Mass.—The electric light committee has recommended that the town put in a plant at a cost of $15,000 and appropriate $2,000 for its maintenance during the ensuing year.

Athol, Mass.—A committee has been appointed to contract with some electric light company. Address L. C. PARMENTER.

Dunkirk, N. Y.—The city has contracted with the Western Electric Light Co., of Chicago, for lighting the city.

Fulton, N. Y.—There has been trouble between the Thomson-Houston and Schuyler electric light companies.

St. Albans, Vt.—The city has contracted for 34 arc lights for street lighting.

New Brunswick, N. J.—The New Brunswick Gas Co. has bid for the next three years $13.92 per lamp per year or one cent. per lamp per hour for 1,362 lamps. The bid of the Edison Co. was $100 per year per light for arc lights of 2,000 candle power each. The deduction was made that if one arc light took the place of six lamps the gas expense would be $81.72 as against $100 for the arc light.

Baltimore, Md.—It is probable the gas companies will consolidate. The Consolidated, Equitable and Chesapeake companies will hold meetings May 5.

Urbana, O.—The city has contracted with the Fort Wayne Jenney Electric Light Co. for arc lights for the streets and incandescent lights for stores and residences.

Columbia, S. C.—The Congaree Gas & Electric Co. has been incorporated. President, Col. JOHN T. SLOAN; Secretary, JOHN P. THOMAS, Jr. Capital stock, $25,000.

Boonville, Mo.—The stock of the Boonville Gas Co. has been bought out and a new company organized. President, WM. HODGE; Secretary, W. M. LIONBERGER.

Helena, Ark.—The city was lighted by electricity for the first time on April 9. There are about 60 lights and incandescent lights will be put in late.

Hiawatha, Kan.—The city has made a 5 years contract with the electric light company. Prof. WHITE, of Lincoln, Neb., is the electrician.

Fort Worth, Tex.—The Fort Worth Electric Light & Gas Co. has increased its capital stock to $300,000; the gas works will be enlarged and an electric plant put in.

San Rafael, Cal.—The San Rafael Gas Co. has put in an electric light plant; with a 60 H. P. boiler and 2 brush dynamos of 30 light capacity each. There are 21 masts and lamps. The company has a 5 years franchise.

Richmond, Que.—The Richmond County Electric Co. is putting in an electric light plant.

Sherbrooke, Que.—The Royal Electric Co., of Montreal, is putting in an electric light plant.

Salisbury, Md.—The test artesian well for the Salisbury Water Co. put down by GEO. B. GULIS, under the supervision of Dr. L. S. BELL, the company's secretary, is an assured success. It is the first well of the kind ever put down in Salisbury and attracts much attention. The well is now down about 100 ft. and is giving a steady stream to a height of 20 ft. above the surface at the rate of 20 galls. per minute, or 1,200 galls. per hour and 288,000 galls. per day, thus showing that this one tube is amply capable of supplying Salisbury with water for domestic purposes. The well was settled as an experiment to ascertain exactly in what stratum the best water could be found. Good water was found at 25 ft. and at 55 ft. the first overflow began. At 59 ft. a 16 ft. bed of pure clay was found, and beneath this fine sand, full of water, which constantly overran the pipe. A small hose nozzle has been screwed on to the top end of the pipe and an impromptu fountain established. Many of our largest farmers are thinking about trying for artesian wells on their farms as an adjunct to the dairy business. The water company is daily expecting the cast-iron pipe for the mains. The Hughes Steam Pump Co., of Cleveland, O., has the contract for the pumping machinery, while the stand-pipe is being built by the Harrisburg Car Works. Nothing but the very best material is being used in the construction of the works, and when completed they will probably be the finest in the State of their size. It is the company's object to give only the purest and best of water, regardless of cost. The works were designed by Dr. BELL, and will be built under his supervision. The company will have no bonded debt, but will be solely the property of the stockholders. It is organized with a capital of $50,000. Baltimore *Sun*.

Special Reports of Water-Works Construction.

THE ENGINEERING NEWS MANUAL OF AMERICAN WATER-WORKS is now being compiled, and will be *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and will be of great value to Water-Works superintendents and projectors of new works.

Superintendents of water-works and water companies will wish to see correct and complete data concerning their Works in our MANUAL, and to ensure this they should send in reports *at once* upon the blanks which we have already sent to every Water-Works office in the United States and Canada. Many have delayed their report, and if the blanks we intended for them have been lost in the mail, or mislaid, we will send more upon request.

We *must* have a report from every public water supply system in North America, so those who reply to our inquiries at once will save a second inquiry. We also wish to know of *every* new Water-Works plant in process of construction, and of *every* new project in this line. We will send to any one desiring them, blanks upon which reports can be made.

Further details of the MANUAL will be advertised later. We abstract from our special reports for the MANUAL the following items of current interest.

TILBURY CENTRE, Ont., April 26, 1888.

EDITOR ENGINEERING NEWS:—Contracts for a system of water-works were let by the village April 25 to Jno. Corrie & Co., London, Ont., for $10,250. Work will begin some time in May and be finished September 1. J. S. RICHARDSON is chairman of the water works board, and BELL & CAMPBELL, St. Thomas, Ont., are the designing and constructing engineers. A. A. WILSON, *Clerk*.

In addition to the above we learn from the designing engineer, JAS. A. BELL, that the mode of supply is direct pumping, and the source a dredged channel connecting with Lake St. Clair; also that the village has contracted with a local milling company for steam to drive its pumps, so no boilers will be needed at present.

MIDDLETOWN, Conn., April 27, 1888.

EDITOR ENGINEERING NEWS:—Portland, Conn., contemplates building water works. Population about 4,500.

J. C. BROATCH, *Supt. Middletown Water-Works.*

CAMDEN, N. J., April 27, 1888.

EDITOR ENGINEERING NEWS:—We are setting up a Blake pump of 10,000,000 galls. capacity, and erecting a stand-pipe for 130 ft. head. W. W. MINES, is Chief Engineer.

GENEVA, N. Y., April 14, 1888.

EDITOR ENGINEERING NEWS:—Contracts are now pending for 100 additional hydrants at a rental of $15 each per annum. Our works were begun in 1787. Since then extensions have been made and more are intended for 1888, after which, every building in the village will have fire protection. Numerous improvements were made in 1887. The population of Geneva is estimated at 7,500.

SAML. S. GRAVES, *Supt. Geneva Water-Works Co.*

Annual Reports.

Springfield, Mass.—The Water Commissioners have issued their report for 1887. The quality of the water has been improved. The works were built in 1864, 1874 and 1887, and are owned by the city. The supply is by gravity from impounding reservoirs in Ludlow and Belchertown. The estimated population is 40,000, 34,500 on the line of pipe, and 29,800 supplied; total consumption 1,460,000,000 galls., of which 102,699,803 passed through meters. There are now in use 81.55 miles of wrought iron, wrought-iron cement lined, and cast iron distribution pipes; during the year 28,406 ft. were laid and 13,000 ft. discontinued; 38 hydrants and 27 stop gates were added, totals 528 and 723. The range of pressure is 90 to 120 lbs. high service, and 30 to 35 lbs. low pressure. There were 123 meters added, total 472. J. C. HANCOCK is superintendent.

Northampton, Mass.—The Water Commissioners have issued their report for the year ending Nov. 30, 1887. The Superintendent reports the works in good condition; 7,939 ft. of pipe were added, and 2,863 ft. relaid with larger pipe; also 12 new fire hydrants set. JONAS M. CLARK is Superintendent.

New Bedford, Mass.—The Water Board has issued its report for 1887, being the 18th annual report. An act has been passed giving the Board authority to use the water from Little Quittacas pond, and an ample supply can now be obtained from this source. The works were built 1866 69 and are owned by the city. The supply is from a storage reservoir formed by damming the Acushnet river; the water flows by gravity to the city and is pumped to a distributing reservoir on an elevated site. The pumping plant was built by H. R. Worthington and the Quintard Iron Works. The total consumption was 1,112,302,789 galls., of which 2,852,326 galls., passed through domestic and 189,165,274 galls. through manufacturers' meters. The distribution mains are 4 to 30-in., wrought-iron cement lined and cast-iron. There are 84¾ miles of pipe, 410 hydrants and 547 stop gates. The pressure is 29 to 37 lbs. There are 60 domestic and 42 manufacturing meters. Estimated population, 36,000; 30,080 supplied. The report is very full and complete; it includes tables of work done, a diagram of the consumption and an interesting report on the test of two upright Corliss boilers. R. C. P. COGGESHALL is Superintendent.

Lawrence, Mass.—The Water Board has issued its report for 1887, being the 12th annual report. The Board has had experiments made on the filtration of sewage, to see if sewage can be deposited on the valley and so purified that the water flowing through the sand will be suitable to turn into a stream from which a domestic water supply is obtained. The total consumption was 919,841,995 galls. There are 53.64 miles of mains, 496 hydrants, 660 stop gates and 918 meters. A. H. SALISBURY is Superintendent.

Middleboro, Mass.—The Water Commissioners have issued their report for 1887, being the 2nd annual report. There are now 9¾ miles of 4 to 12 in. pipe, 78 hydrants, 84 valves, and 78 meters. The total consumption was 26,538,200 galls. JOSEPH E. BEALS is Clerk of the Water Board.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(*Specially Communicated.*)

(CONTINUED FROM PAGE 326).

Swanton, Vt.—The works were commenced Aug. 15, 1887, and completed Oct. 20, 1887. W. H. LANG, of Burlington, Vt., was the engineer; and Lang, Goodhue & Co., of Burlington, were the contractors. The supply is by direct pumping from the Mississquoi river; a Lang triplex pump of 1,000,000 galls. daily capacity, driven by a "Hercules" turbine, being used. There are 3 miles of Wyckoff wood pipe, 100 taps and 30 hydrants; the service pipes are of iron. Average daily consumption, 250,000 galls. Ordinary pressure, 50 lbs.; fire pressure, 100 lbs. The works cost $30,000, and are to be sold to the town at actual cost. The annual expense is $250; annual revenue from consumers about $1,300. The works are owned by the Swanton Water-Works Co.; F. FARBLE, H. M. STONE, E. W. JEWETT; capital stock, $20,000. W. H. LANG is Superintendent.

Newark, N. Y.—The works were commenced Sept. 1, 1887, completed Dec. 1, 1887, and accepted by the trustees. The engineer was F. S. PECKE, of Watertown, N. Y. The contractors were Moffett, Hodgkins & Clarke, of Watertown, N. Y.; the pumping machinery was furnished by H. R. Worthington, of New York; the pipe and specials by the Warren Foundry & Machine Co., of New York, the Jackson & Woodin Mfg. Co., of Berwick, Pa., and the Sayre Pipe Foundry, of Sayre, Pa.; the valves and hydrants by the Ludlow Valve Mfg. Co., of Troy, N. Y.; the stand-pipe by Riter & Conley, of Pittsburg, Pa. The water is pumped from a reservoir of 1,250,000 galls. capacity, supplied by springs, to a steel water tower, 20 ft. diameter and 80 ft. high. The pumping machinery consists of 2 Worthington pumps, one 10 and 16 × 10¼ × 10 and one 16 × 10¼ × 10; aggregate daily capacity, 2,000,000 galls.; with 2 80 H. P. steel return tubular boilers. There are 7½ miles of pipe and 71 hydrants, one being at the pumping station; the service pipes are of galvanized iron. Ordinary pressure, 67 lbs.; fire pressure 140 lbs. The works are owned by the Newark Water-Works Co.; President, J. F. MOFFETT; Secretary, C. T. MOFFETT; capital stock $100,000. The present population is 5,000.

Hudson, Wis.—The works were commenced July 30, 1887, and completed about May 1, 1888; they were designed by H. H. HARRISON, of Stillwater, Minn.; and JAS. A. ANDREWS, of Hudson, Wis., was Constructing Engineer. The contractors were, for masonry, foundations and buildings, P. Kurcher, of Hudson; for pumping machinery, Geo. G. Blake Mfg. Co., of New York; for pipe and specials, Ohio Pipe Co., Columbus, O.; for valves and hydrants, Galvin Brass & Iron Works, Detroit, Mich. The supply is drawn from artesian wells and pumped to a reservoir with a capacity of 750,000 galls., by a pump with a daily capacity of 1,000,000 galls. There are 3 miles of cast-iron pipe, 40 hydrants and 47 taps; the service pipes are of wrought-iron. Ordinary pressure 90 lbs.; fire pressure, 90 to 100 lbs. Cost of works, $40,000; debt, $30,000; rate of interest, 4 per cent. The works are owned by the city, which has issued bonds for $30,000. C. P. COON, Superintendent. The present population is 3,500.

(TO BE CONTINUED).